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Morningglories in the Delta of Mississippi

Southern Weed Science Laboratory
ARS, USDA, Stoneville Mississippi
in cooperation with

MAFES MISSISSIPPI AGRICULTURAL & FORESTRY EXPERIMENT STATION
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Morningglories in the Delta of Mississippi

Morningglories are common and oublesome weeds in most crops in ssissippi. They are increasing in onomic importance throughout e state, regardless of the crop. ey reduce crop yields, increase e difficulty of harvesting, reduce e quality of harvested produce d greatly increase the cost of oduction.

Many producers have considered rninglories to be a single weed, t there are many different rninglories. Several different ecies of morningglories are fficult to identify accurately, pecially before flowers are proced.

Accurate identification is more important at present because certain widely used herbicides will provide effective control of some morningglory species but are ineffective on others. For example, bentazon applied postemergence in soybeans is highly effective for control of smallflower morningglory and palmleaf morningglory but is ineffective for control of entireleaf, ivyleaf, pitted and tall morningglory and purple moonflower (also a member of the morningglory family). Metribuzin applied preemergence is highly effective for control of smallflower morningglory and moderately effective for the control of pitted morningglory and purple moonflower but is ineffective for control of entireleaf, ivyleaf, palmleaf and tall morningglory.

Because of the increasing importance of the morningglories, we have developed criteria for identifying the species that may occur in Mississippi and have conducted a survey of the Delta of Mississippi for individual morningglory species. Our objective was to determine the level of infestation in cotton and soybean fields by each species of morningglory found.

Procedure

he 100 random sites selected for field survey were apportioned ong the counties according to h county's planted acreages of ton and soybeans. The sites were ermined by randomly selecting age from the aerial photographs the county soil survey. The site s then randomly selected from a d placed over the photograph of selected page. Lakes, forests d other uncultivated sites were t included in the survey. Alternate es were selected if land use had anged since the aerial photographs were taken (eg, rice paddy or catfish pond).

The predetermined sites were surveyed in late August 1981 and late August-early September 1982. Fields were sampled by a walking survey. Data recorded for each site included crop planted, presence of morningglories by species and an abundance rating by species according to the following scale:

0 = none present
1 = rare, 1 to a few plants seen (< 1% area coverage)
2 = infrequent, more than 1 (1-10% area coverage)
3 = occasional (10-20% area coverage)
4 = common (20-50% area coverage)
5 = abundant (> 50% area coverage).

Two observers made independent ratings and assigned rating was by consensus. A few sites were visited by a single observer, but only after considerable experience had been achieved.

Results and Discussion

ix species of morningglories were nd in our survey, but all six were t found each year. Species found re pitted morningglory, ivyleaf[1] d entireleaf[1] morningglory, palmf morningglory, bigroot morningry, smallflower morningglory d and purple moonflower. Three er species (tall morningglory, ton morningglory and cypress vine morningglory) have been seen in the Delta; however, these species were not seen in any of the fields sampled.

Pitted morningglory was found in the most fields during the two-year survey (Table 1). Pitted morningglory and *hederacea* (ivyleaf and entireleaf) were equally frequent in 1981. Ivyleaf and entireleaf decreased in frequency in 1982 (only 47% of the fields had these morningglories), while occurrence of pitted morningglory increased (to 67%).

Soybean fields had more morningglories than did cotton fields. Pitted morningglory occurred in about 50% of the cotton fields and 75% of the soybean fields in both years. Both

[1] leaf and entireleaf are varieties of the same species, *Ipomoea hederacea*, (L.) Jacq.

Table 1. Frequency of occurrence and severity of infestation of different morningglory species in cotton and soybean fields in the Delta of Mississippi in 1981-82.

Crop	No. of Fields	Morningglory species																		
		Pitted			Hederacea[1]			Palmleaf			Bigroot			Purple moonflower			Smallflow		
		Rating																		
		0	1	>1	0	1	>1	0	1	>1	0	1	>1	0	1	>1	0	1	>
		% of fields																		
		1981																		
Cotton	43	53	12	35	60	15	23[2]	93	0	7	79	12	9	100	0	0	100	0	
Soybean	57	25	21	54	18	37	46	61	21	18	86	11	4	100	0	0	96	4	
Total	100	37	17	46	36	28	36	75	12	13	83	11	6	100	0	0	98	2	
		1982																		
Cotton	35	49	23	28	77	9	14	97	3	0	91	0	9	100	0	0	100	0	
Soybean	65	25	18	57	40	20	40	69	11	20	98	0	2	98	0	2	97	3	
Total	100	33	20	47	53	16	31	79	8	13	96	0	4	99	0	1	98	2	

[1] Includes both ivyleaf and entireleaf morningglory without distinction

[2] Rounding errors preclude adding up to 100

Table 2. Severity of infestation of cotton and soybean fields for morningglories in the Mississippi Delta for 1981 and 1982.

Crop	No. of Fields	Pitted	Hederacea[1]	Palmleaf	Bigroot	Purple moonflower	Smallflo
		1981 Average rating					
Cotton	43	1.0	0.8	0.1	0.3	0	0
Soybean	57	1.6	1.4	0.7	0.2	0	< 0.1
Total	100	1.4	1.1	0.4	0.3	0	< 0.1
		1982 Average rating					
Cotton	35	1.0	0.4	< 0.1	0.2	0	0
Soybean	65	1.5	1.2	0.4	< 0.1	< 0.1	< 0.1
Total	100	1.3	0.9	0.4	0.1	< 0.1	< 0.1

[1] Includes both ivyleaf and entireleaf without distinction

ops had less ivyleaf and entireleaf orningglory in 1982 than in 1981. The third most frequent morningory was palmleaf. It was seen ore frequently in soybean fields d was confined almost exclusively the clay soils of the Delta.

Bigroot morningglory, a perenal, was found most frequently in tton fields. The reason for the cline of this species in 1982 is not own. Purple moonflower and allflower morningglory, although rarely seen in our survey, can cause severe weed problems. Purple moonflower was seen in 1982 in only one field in the south Delta (a newground soybean field in Issaquena County). Smallflower morningglory was seen in two soybean fields east of the Tallahatchie River. The moonflowers were infrequent weeds in our survey, but they are known to create severe weed problems in isolated situations throughout the Delta.

The average rating (severity of infestation) for morningglories tended to parallel their occurrence each year (Table 2). The most serious morningglory was pitted followed by ivy and entireleaf, palmleaf, bigroot, purple moonflower and smallflower morningglory. Pitted morningglory was the most common and most troublesome.

Identification of morningglories is difficult, even for weed professionals. This is aggravated by some published weed identification guides that contain mistakes. An illustrated guide and key is as follows:

Key to the Morningglories of the Delta

Flowers in heads of 10 or more	*Jacquemontia tamnifolia* (L.) Griseb.- smallflower morningglory (Figure 1.)
Flowers solitary or in 2-5 flowered groups	*Ipomoea*

Key to *Ipomoea* Species

A. Leaves deeply divided to base	*I. wrightii* Gray- palmleaf morningglory (Figure 2.)
A. Leaves unlobed or shallowly lobed	
B. Stems with soft spines	*I. muricata* (L.) Jacq.- purple moonflower (Figure 3.)
B. Stems smooth, without spines	
C. Leaves and flower stalks noticeably hairy	
D. Sepals short, blunt; flowers 1½ -2″ long, usually purple	*I. purpurea* (L.) Roth- tall morningglory (Figure 4.)
D. Sepals long, narrow, flowers 1-1½″ long, usually blue	*I. hederacea* (L.) Jacq. (Figure 5)
E. Leaves 3-lobed	var. *hederacea*- ivyleaf morningglory
E. Leaves unlobed	var. *integriuscula* Gray- entireleaf morningglory
C. Leaves and flower stalks not noticeably hairy	
F. Flowers less than 1″ long and wide, lavender or white	*I. lacunosa* L.- pitted morningglory (Figure 6.)
F. Flowers more than 1″ long and wide	
G. Plant perennial; flowers white with purple center	*I. pandurata* (L.) Meyer- bigroot morningglory (Figure 7.)
G. Plant annual, flowers lavender	*I. trichocarpa* Ell.- cotton morningglory (Figure 8.)

Figure 1. Smallflower morningglory, *Jacquemontia tamnifolia* (L.) Griseb.

igure 2. Palmleaf morningglory, *Ipomoea wrightii*, (L.) Gray.

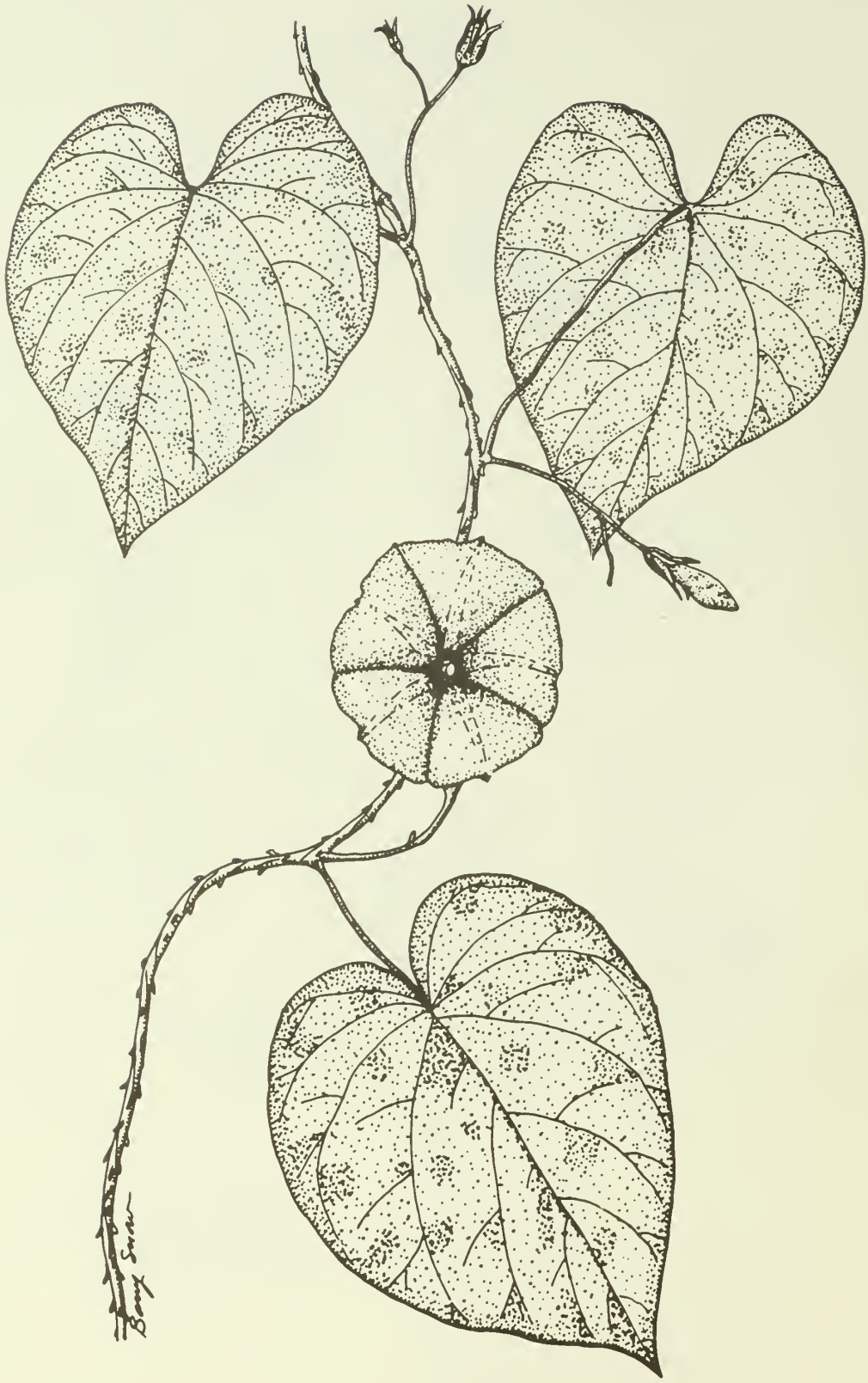

Figure 3. Purple moonflower, *Ipomoea muricata* (L.) Jacq.

ɜure 4. Tall morningglory, *Ipomoea purpurea* (L.) Roth.

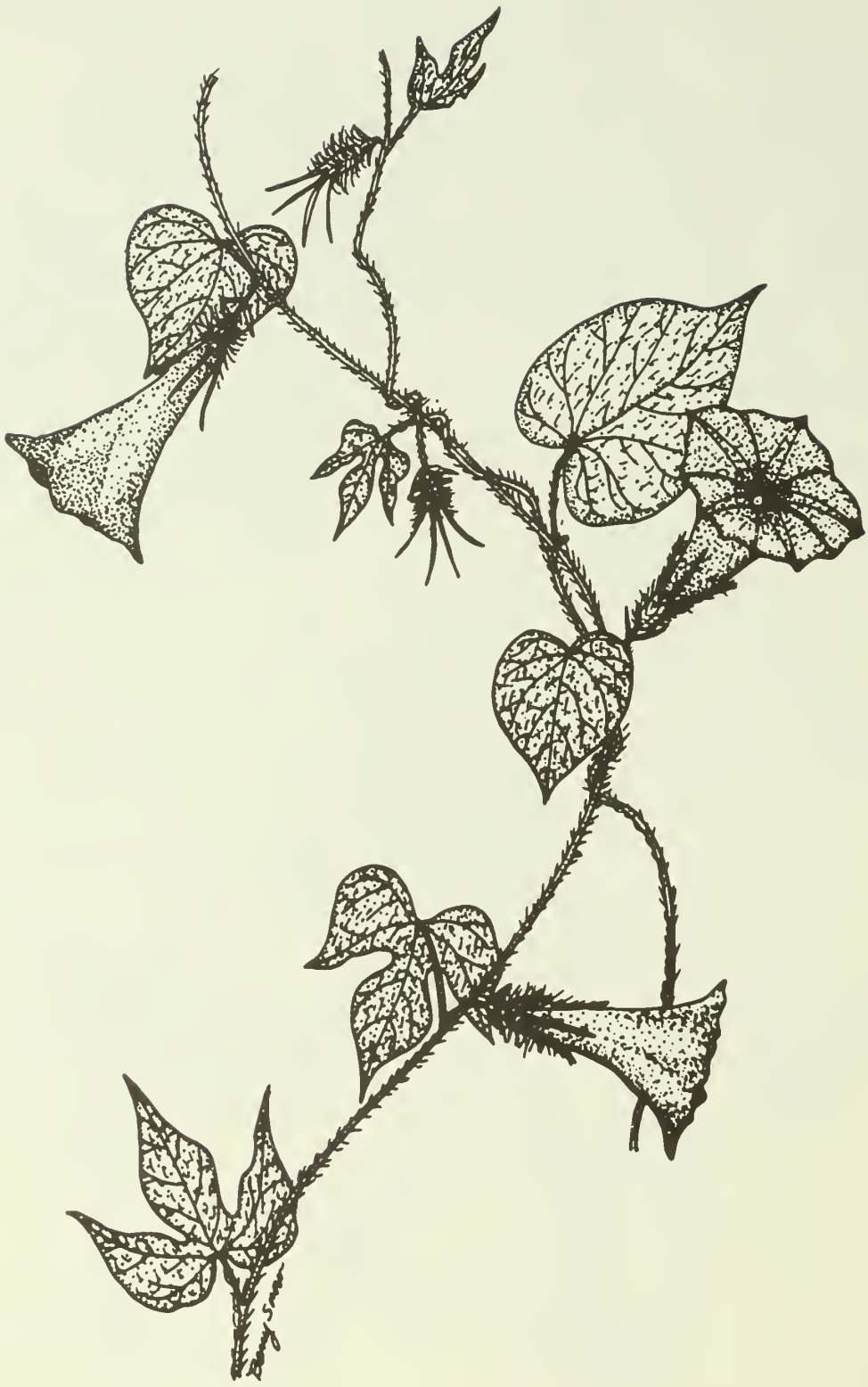

Figure 5. Ivyleaf and entireleaf morningglory, *Ipomoea hederacea*, (L.) Jacq.

gure 6. Pitted morningglory, *Ipomoea lacunosa* L.

Figure 7. Bigroot morningglory, *Ipomoea pandurata* (L.) Meyer.

ıre 8. Cotton morningglory, *Ipomoea trichocarpa* Ell.

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General Characteristics of Selected Cotton Varieties

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General Characteristics of Selected Cotton Varieties

ld usually receives the primary nsideration when selecting a ton variety, but other varietal racteristics also merit considera-n. Maturity, seedling vigor, fiber perties and disease resistance additional characteristics that erve some consideration. Several dies of yield, earliness, fiber perties and plant populations ve been published (1, 2, 3, 4, 9, . These data are presented to ect varietal differences in seed, d/boll, boll size, percent linters, protein, gossypol, plant height l disease characteristics.

erformance of a variety can be uenced by seed quality, planting e, cultural practices, fertilization, gation, weather, plant popula-ns and weed and insect control. characteristics of a variety are d by the genotype or inherent ential of the plants that make ny given variety. Under ideal wing conditions and the most careful ginning, the quality of the variety cannot exceed the upper limits imposed by heredity.

Seed Size and Number Seed Per Pound

Seed size is described as the seed index, which is the weight in grams of 100 seed. The average seed index of ten varieties over a three-year period (4) in 12 Delta environments is presented in Table 1. These measurements were made on fuzzy seed (gin-run), and seed-index values ranged from 9.1 for Deltapine 41 to 11.4 for Coker 310. In comparing varieties, Deltapine 41 had about 1000 more seed per pound than did Coker 310, which means, at a planting rate of 15 lbs/A, a potential for 15,000 more plants per acre for Deltapine 41 if both varieties are seeded at the same rate (lbs/A).

The average number of seed per pound of 15 cotton varieties in three Delta environments is presented in Table 2. These data represent varietal difference for both fuzzy and acid-delinted seed and show that, on the average, there are about 700 more seed per pound in acid-delinted seed than in fuzzy seed. These data indicate that seed size differs by locations, but the varietal rankings remain relatively the same. These data again show that Deltapine 41 has about 1000 more seed per pound than Coker 310. The average number of seed per pound from acid-delinted, uncleaned samples of the three test environments in 1981 range from 4,509 to 5,738. The column labeled "breeders" represented cleaned and treated acid-delinted seed furnished by breeders for testing in 1981. The number of seed per pound in these breeder samples ranged from 4,460 to 5,483. The number of seed per

Table 1. General characteristics of ten cotton varieties.[1/]

Variety	Lint percent	Seed index	Seed/lb[2/] fuzzy seed	Seed/boll	Boll size grams	Bolls/lb
DES 422	38.9	10.2	4,450	28.1	4.70	97
Stoneville 825	38.1	10.7	4,243	27.6	4.78	95
DES 56	37.8	10.6	4,283	28.0	4.78	95
Deltapine 41	41.3	9.1	4,989	30.4	4.71	96
Stoneville 506	37.0	10.9	4,165	28.0	4.84	94
Stoneville 213	37.9	10.6	4,283	29.2	4.98	91
McNair 235	37.9	10.7	4,243	27.7	4.78	95
Deltapine 55	39.5	9.9	4,586	29.9	4.89	93
Coker 315	38.0	11.0	4,127	29.3	5.20	87
Coker 310	36.8	11.4	3,982	30.4	5.48	83

[1/] Three-year average (1979-81) of twelve Delta environments (Stoneville 6, Tunica 3, Sumner 3).

[2/] Gin-run fuzzy seed.

pound of a given variety may vary due to the environment in which the seed are grown and the amount of cleaning they receive.

The relative differences in seed size of cotton varieties may require the use of different planter plates or sprocket ratios to insure the proper planting rate. The germination and vigor of planting seed also should be measured to determine seed quality. In 1981, approximately 72% of the planting seed emerged to healthy plants when high vigor seed with a germination of 90% were planted.

Boll Size and Number Seed Per Boll

Data presented in Table 1 show that boll size (grams/boll) ranged from 4.70 to 5.48 which represented 97 bolls/lb for the smallest-bolled variety and 83 bolls/lb for the largest-bolled variety (4). If yield estimates are attempted by boll counts, the relative genetic differences in boll size between varieties should be considered. In addition, environmental factors cause boll size to vary within a year (early vs. late bolls), from year to year and from location to location. The number of seed per boll of the ten varieties ranged from 27.6 to 30.4 (Table 1).

Linters

The average percent linters of 15 cotton varieties grown in three Delta environments in 1981 is presented in Table 3. The average percent linters in these tests ranged from 14.46 to 19.56, with Stoneville 213, Deltapine NSL and Stoneville 825 having the highest percentages. These data are in agreement with those from Mississippi Delta tests (Arkansas, Louisiana, Missouri Mississippi) in 1979 (Table 4), wh showed Stoneville 213 a Stoneville 825 as having the high percent linters. The average perc linters was 17.16, 15.48 and 17 respectively, for the Stonevi Tunica and Sumner environme in 1981. Seed grade, which i visual estimate of the amoun linters on seed, ranged from 3.2 Stoneville 213 to 4.4 for Deltap 61.

Oil, Nitrogen and Gossy Content of Seed

Seed data of cotton variet evaluated in the 1979 Delta Regio Variety Testing Progr (Arkansas, Missouri, Mississi and Louisiana) are presented Table 4. The average percent oi the eleven varieties evaluated ra ed from 18.0 for Deltapine 41 to 2

Table 2. Average number of seed per pound of 15 cotton varieties grown in three Delta environments in 1981.

Variety	Stoneville, MS		Tunica, MS		Sumner, MS		Average[1/]		
	fuzzy	acid-delinted	fuzzy	acid-delinted	fuzzy	acid-delinted	fuzzy	acid-delinted	Breeder
DES 422	4,540	5,279	4,540	5,188	4,017	4,680	4,365	5,049	5,012
Stoneville 213	4,540	5,437	4,495	5,341	3,913	4,729	4,316	5,169	4,590
DES 56	4,283	5,072	4,680	5,309	4,165	4,829	4,376	5,070	4,830
McNair 235	4,323	5,016	4,680	5,341	3,752	4,386	4,252	4,914	4,794
Stoneville 825	4,540	5,404	4,540	5,372	3,913	4,680	4,331	5,152	4,460
McNair 220	4,090	4,656	4,585	5,248	3,721	4,345	4,132	4,749	5,050
Deltapine 41	4,881	5,675	5,536	6,135	4,779	5,404	5,065	5,738	5,483
Coker 315	3,982	4,704	4,323	4,778	3,721	4,365	4,009	4,616	4,978
Deltapine 55	4,729	4,704	4,881	5,820	4,203	4,881	4,604	5,135	4,632
Deltapine 62	4,053	4,855	4,451	5,129	3,815	4,609	4,106	4,864	4,526
Deltapine NSL	4,495	5,404	4,778	5,570	4,203	5,072	4,492	5,349	4,892
Stoneville 506	4,243	4,934	4,829	5,604	3,815	4,472	4,296	5,004	4,800
Coker 3131	4,017	4,585	4,203	4,778	3,632	4,165	3,951	4,509	4,799
HAS 2344	4,407	5,159	4,829	5,570	4,203	4,989	4,480	5,239	5,248
Coker 310	3,913	4,540	4,323	4,934	3,783	4,407	4,006	4,627	4,908
Average	4,336	5,028	4,645	5,341	3,976	4,667	4,319	5,012	
Difference		692		696		691		693	

[1/] Represents uncleaned and untreated acid-delinted seed from three Delta environments.

[2/] Represents cleaned and treated acid-delinted seed furnished by breeders for testing in 1981.

Table 3. Average percent linters of 15 cotton varieties grown in three Delta environments in 1981.

Variety	Stoneville, MS	Tunica, MS	Sumner, MS	Average
DES 422	16.3	14.3	17.0	15.86
Stoneville 213	19.1	18.8	20.8	19.56
DES 56	16.2	12.9	16.5	15.20
McNair 235	16.0	14.7	16.9	15.86
Stoneville 825	19.0	18.3	19.6	18.96
McNair 220	14.4	14.4	16.7	15.17
Deltapine 41	16.9	11.5	17.9	15.43
Coker 315	18.1	16.6	16.4	17.03
Deltapine 55	16.3	19.2	16.7	17.40
Deltapine 62	19.8	15.2	20.8	18.60
Deltapine NSL	20.8	16.6	20.7	19.36
Stoneville 506	16.3	16.0	17.2	16.50
Coker 3131	14.6	13.7	15.1	14.46
HAS 2344	17.6	15.9	18.7	17.40
Coker 310	16.0	14.1	15.5	15.20
Average	17.16	15.48	17.76	16.80

Three Delta environments: Stoneville, Tunica, and Sumner.

Table 4. Seed characteristics of 11 cotton varieties in Mississippi Delta tests in 1979.[1/]

Variety	% Oil	% Nitrogen	% Free Gossypol	% Linters	Seed grade	% Floaters	Acid-delinted seed index	Seed/lb[2/]
Deltapine 41	18.0 d	3.29 c	1.08 bc	11.7 bcd	4.3 ab	4.4 bc	9.0 e	50,444
Deltapine 55	19.2 bc	3.25 cde	1.21 a	12.1 bc	3.8 bc	3.8 bc	9.5 d	47,789
DES 56	20.2 b	3.29 c	1.25 a	11.6 bcd	3.8 bc	2.2 c	9.9 bc	45,858
Stoneville 825	18.8 c	3.14 fg	1.25 a	13.4 a	3.5 cd	5.6 ab	9.9 bcd	45,858
McNair 235	20.3 ab	3.26 cd	1.06 c	11.2 cd	3.8 bc	6.7 a	9.6 cd	47,292
Deltapine 61	19.3 bc	3.10 g	1.05 c	11.5 bcd	4.4 a	3.4 c	9.5 d	47,789
Stoneville 213	19.0 c	3.19 ef	1.20 a	13.5 a	3.2 d	4.3 bc	10.0 bc	45,400
Coker 310	20.2 b	3.21 def	1.13 b	12.2 b	3.4 cd	3.6 bc	10.1 b	44,950
Coker 304	20.7 ab	3.29 c	1.12 b	12.1 bc	3.9 abc	2.7 c	10.1 b	44,950
Paymaster 303	21.0 a	3.36 b	.95 d	11.1 d	3.6 cd	3.9 bc	11.3 a	40,177
Acala SJ-5	20.7 ab	3.45 a	.84 e	9.9 e	3.6 cd	3.9 bc	11.2 a	40,535

[1/] Regional Cotton Variety Tests, 1979. USDA publication A106.28:979. Data compiled by H. H. Ramey, Jr., N. J. Acres, and M. K. Barringer. Data represents the average of tests conducted at Marianna and Clarkedale, Arkansas; Stoneville and Tunica, Mississippi; Portageville, Missouri; and St. Joseph, Louisiana in 1979.

[2/] Calculated from acid-delinted seed index.

for Paymaster 303. The percent nitrogen ranged from 3.10 for Deltapine 61 to 3.45 for Acala SJ-5. The percentage of nitrogen multiplied by 6.25 is an approximation of the percentage of protein. The percent free gossypol ranged from 0.84 for Acala SJ-5 to 1.25 for DES 56 and Stoneville 825.

Floaters

Seed that float in water are considered immature, and a higher percentage indicates more immaturity within a variety. The percent floaters in this study ranged from 2.2% for DES 56 to 6.7% for McNair 235. These data represent values obtained from uncleaned seed, and the immature seed (floaters) are usually removed by proper cleaning and processing (8). Seed of some varieties also have a thinner seed coat, which may present a problem in ginning and processing as they will have more cracked seed and potential vigor deterioration.

Plant Height

The average plant height of several varieties is presented in Table 5. The three-year average of 11 varieties shows that plant height ranged from 39.4 to 44.4 inches. The plant height of a variety may vary from year to year and location to location, depending on the environmental conditions encountered. However, these data represent the relative height differences between varieties at Stoneville.

Fusarium Wilt

The average percent *Fusarium* wilt as reported by Kappelman et al. (5, 6, 7) for the Regional *Fusarium* Wilt Screening Test, Tallassee, Alabama is presented in Table 6. This test is very helpful to breeders in obtaining unbiased estimates of

Table 5. Average plant height of 15 varieties grown at Stoneville, MS over a 3-year period (1979-81).

Variety	1979	1980	1981	3-year average
			(inches)	
Deltapine 62[1/]	52.2	40.6	40.4	44.4
Stoneville 825	49.2	38.6	43.6	43.8
Coker 310	49.8	39.1	41.2	43.4
Coker 315	50.7	39.3	40.0	43.3
Stoneville 213	49.0	37.9	41.2	42.7
Deltapine 55	48.6	35.4	41.4	41.8
DES 56	46.0	36.9	40.3	41.1
Deltapine 41	46.0	34.8	40.6	40.5
McNair 235	44.6	36.5	40.5	40.5
DES 422	44.1	35.6	39.7	39.8
Stoneville 506	43.5	34.9	39.8	39.4
Coker 3131	-	38.4	41.9	-
McNair 220	-	-	39.1	-
HAS 2344	-	-	40.6	-
Deltapine NSL	-	-	43.1	-

[1/] Data for Deltapine 61 used for 1979 and 1980.

Table 6. Average percent Fusarium wilt in the Regional Fusarium Wilt Screening Test, Tallassee, Alabama, 1979-81.

Variety	1979	1980	1981	3-year average
			(%)	
Stoneville 825	51.2	82.8	14.3	49.4
Stoneville 213	64.5	68.8	11.4	48.2
Deltapine 41	26.0	52.3	9.8	29.4
Coker 315	25.9	44.2	4.5	24.9
Coker 310	34.9	35.2	1.7	23.9
DES 56	25.9	35.5	8.4	23.3
Deltapine 61	26.9	29.8	7.3	21.3
Deltapine 55	18.0	26.4	7.1	17.2
McNair 220	14.4	32.9	0.5	15.9
McNair 235	16.9	24.6	4.5	15.3
Stoneville 506	-	33.8	4.8	-
Coker 3131	-	36.0	11.8	-

sarium resistance for their rieties and experimental strains. e average *Fusarium* wilt over a ee-year period, 1979-1981, ranged m 15.3 to 49.4%. Stoneville 825 d Stoneville 213 showed the ghest percent wilting, and McNair 5 and McNair 220 showed the vest. Stoneville 506 and Coker 31 have been evaluated for only o years. In similar tests at the same location, DES 422 has shown about 7% less wilting than DES 56. Louisiana tests conducted on soils infested with *Fusarium* wilt and root knot nematode have indicated that Deltapine 26, Deltapine 41, Deltapine 61, DES 56, Stoneville 506 and Gumbo 500 perform better than other varieties under these conditions.

These data are presented to demonstrate that varietal differences for traits other than yield, earliness and fiber properties may be useful in variety selection. The varieties used in these comparisons are those usually considered adapted to Mississippi.

Term Definitions

ll size. The weight, in grams, per l of seed cotton.

t percent. The weight of lint ned from a sample of seed cotton, pressed as a percentage of the ght of seed cotton.

nters. The weight of linters noved in the acid-delinting cess, expressed as a percentage he weight of the fuzzy seed.

d index. The weight of 100 seed, grams (fuzzy or acid-delinted).

d grade. A visual estimate of the ount of linters on seed. Seed are graded from 1 to 16; 1 = dense coating and 16 = no linters (naked seed).

Floaters. The number of acid-delinted seed that float in water, expressed as a percentage of the number of seed in the sample. Seed that float in water usually are immature.

Free Gossypol. The gossypol in fuzzy seed as determined by AOCS Method Ba 7-58; expressed as a percentage of the mass of the kernel.

Nitrogen. The nitrogen in fuzzy seed as determined by AOCS Method Ba 4-38; expressed as a percentage of the mass of the fuzzy seed. The percentage of nitrogen multiplied by 6.25 is an approximation of the percentage of protein.

Oil. The oil in fuzzy seed as determined by AOCS Method Aa 4-38; expressed as a percentage of the mass of the fuzzy seed.

Seed percent. 100 - lint percent.

$$\textit{Seed per boll} = \frac{\text{Seed \% x Boll Size}}{\text{Seed Index}}$$

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J. P. Overcash examines 'Cape Fear' pecan trees in 3-gallon containers. The trees have three-year-old roots and two-year old tops.

Research With Pecan Nursery Trees in Containers and Orchards

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Summary

A number of nurseries now are producing container-grown, grafted pecan trees for commercial orchards and home landscapes. Success with this technique requires careful attention to the details of cultural procedures, some of which are as follow:

(1) Seed source should be selected carefully. Large, heavy nuts generally germinate well and produce larger seedlings than do those from poorly filled, small nuts (5). Nuts from one cultivar are better than nuts from randomly selected seedlings or cultivars.

(2) Seed should be stratified to encourage prompt and uniform germination. Store seed with moist peat moss at about 40°*F* for six weeks or longer before planting.

(3) Germinating seedlings often are disturbed (eaten) by pests such as rats, squirrels and various bird species. It is sometimes necessary to protect seedlings from these pests by covering them temporarily until they are well established. This can be done by covering them with a fine wire screen or loose mesh shade cloth or by germinating them in a greenhouse or wire cage. In research, three seed often are planted per container to assure one strong seedling. However, many seed can be germinated in containers or in a bed with a cage covered with a screen cloth. Strong seedlings are selected shortly after germination for transplanting, one per container, in the growing area. This is the most efficient use of seed.

(4) Several types of containers are available, but the 3-gallon black plastic nursery container is used most often. It holds enough potting mixture to permit supplemental addition of nutrients to grow large trees over a period of two to three years (2,3). Seedlings grown in the 10 x 20-inch nursery container have a larger root volume at transplanting time and may produce more tree growth when transplanted to the orchard.

(5) The Bostian-Overcash (3) potting mixture generally has been satisfactory for growing pecan nursery trees in container research. The mixture is about 50% pine bark ⅛- to ⅞-inch diameter, 38% mason sand and 12% fumigated soil (with weed-insect-disease control). The pH of the potting mixture must be adjusted to the proper range (6.0-6.5) if optimum plant growth is to be attained. Dolomitic lime (Ca & Mg) often is used. The pH should be checked at the end of each year and adjusted if needed. After three growing seasons the potting mixture still will support trees up to 4-7 ft tall. Other potting mixtures also may be fully satisfactory.

(6) Mineral nutrients must be supplied. "Slow release" minerals (N-P-K) plus other elements often are blended with the potting mixture at planting time. Small quantities of boron, calcium, copper, iron, magnesium, manganese, molybdenum, sulphur and zinc also must be supplied to the potting mixture, as dry supplements before blending or as liquid additions after the plants begin to grow.

Supplemental applications of N-P-K, and sometimes other elements, must be made to promote normal growth. During year two or three "slow release" NPK and other elements, or water soluble NPK, must be added to the top of the mixture regularly. Supplemental NPK should be added in the summer at regular intervals (weekly for water soluble and monthly for "slow release" nutrients).

(7) Frequent irrigation of nursery containers is very important because the container severely restricts the amount of roots a the water available to them. Co mercial nurseries often use overl ping sprinklers controlled or au mated by a time clock and solen valve. Overwatering seldom occ with the open, well-drained potti mixture. Trickle irrigation can used with an emitter or dripper each container, and this also can automated by time clock.

(8) When the seed are stratifi and planted at the proper time the spring and proper irrigati and fertilization practices are follo ed, it is possible to grow seedlin large enough to bud in August graft in the following spring.

(9) Diseases and insects must controlled if plants are to ma optimum growth. Some nurse men, who also have pecan orchar design their nursery so that an a blast sprayer can be used with regular orchard chemicals. Perio soil application of recommen chemicals can be effective for c trolling diseases and insects with spraying.

(10) Skilled propagators can l the seedlings effectively in l summer so that they will "tal and be ready for growth in the n spring. Other propagators ef tively use whip grafts at the en the dormant season. In any eve the "grafts" must be handled pro ly so that they will not break ou the graft union. Grafts should set as high as possible on the se ling trunk.

(11) When the rootstock is of a quate size and healthy in ea spring, it is possible to grow strong new trunk for the sc variety in one growing seas Often they will grow from 2 to and harden off. If the scion is large enough to sell or set in orchard, it can be grown a sec summer in the container.

Research with Pecan Nursery Trees in Containers & Orchards

Pecans, *Carya illinoensis* (Koch), re an important horticultural crop. he latest Census of Agriculture ported 4.6 million bearing pecan ees and 2.3 million non-bearing uvenile) trees in the United States. he average annual production arvested) from 1977 through 1982 as 236 million lbs, and the average eld/acre was about 1000 lbs for ature bearing trees.

With 2.3 million juvenile trees -10 years) in the United States, it apparent that pecan producers re interested in either expanding eir present acreage or starting ew orchards. Nurserymen in veral states annually produce large numbers of grafted nursery trees in field nurseries. The trees are dug in the dormant season and are sold bare-rooted to growers for transplanting to orchards in late winter or early spring.

Standard nursery techniques consist of grafting or budding a named cultivar on a seedling rootstock growing in soil in a nursery. Rootstocks are established by planting nuts (often from known cultivars) in rows in late winter or early spring. The germinated seedlings require hand weeding, cultivating, fertilizing and pesticide spraying until they are large enough to bud or graft and the cultivar tree is large enough to sell. Establishing the seedlings usually requires from one to three years, and one or more years then are required to grow the cultivar grafts to a size suitable for sale.

Research and practical experience have shown the possibility of producing pecan nursery trees in containers (Figure 1) and transplanting them to the orchard (Figure 2). Production of nursery plants in containers (especially ornamental plants) has increased in the United States in the last two decades (11). The many advantages to nurserymen are (1) more plants can be grown per acre, (2) need for large fields of good soil is eliminated, (3)

Figure 1. Mr. and Mrs. Bob Williams display a 'Melrose' pecan tree grown on a seedling rt in their nursery at Newellton, Louisiana. The rootstock is three years old and the n variety is one year old (Photographed October 1980).

Figure 2. Mr.and Mrs. Bob Williams of Newellton, Louisiana produce pecan nursery trees in containers in their nursery. This is a 'Candy' tree in its fifth leaf and was transplanted from a 3-gallon nursery container.

many phases in container plant production can be mechanized, (4) the potting mixture can be prepared to provide suitable pH and nutrient requirements, (5) the potting mixture can be fumigated to reduce diseases, insects and weeds, and (6) plants grown in containers can be sold and transplanted to landscapes or orchards during the dormant or growing season.

Container production of pecan nursery trees requires well-drained potting mixtures that have good nutrient holding capacity and are of light weight (9,10). Containers restrict the root zone; therefore, frequent watering is required during the growing season. This can be automated for daily or more frequent applications to larger trees. Trickle devices or overhead sprinklers can be used to provide water.

Nursery site preparation for efficient container plant production requires provisions for water runoff as well as irrigation. Black containers exposed to full sun in the hottest part of summer may cause root injury unless containers are placed close together. Sprinkler irrigation at mid-day may be used to reduce build-up of heat in the nursery. Pecan nursery containers may need to be mulched with sawdust in the winter to protect the plants from severe cold. We have not observed winter killing of containerized pecan trees that were adequately mulched, even when the ambient temperature dropped to 0°F.

Mineral nutrition for container-grown nursery trees represents a complex problem (4,6). Nitrogen, phosphorus and potassium are recognized as major elements of the 15 recognized as essential for plant growth, because of the relatively large amounts needed. In recent years the N-P-K group has been developed as "coated" pellets with "slow release" availability. These generally are available in rated time-of-release groups, such as three-to-four or eight-to-nine months. Uniform soil moisture and ambient temperatures contribute to uniform release of these elements over time. However, soil moisture and ambient temperatures are not uniform o time, and nutrient release can v with differences in growing-sea conditions such as warm, high very high air temperatures normal or excessive natural rain (4,6). Elements in addition to N-P sometimes are included in the "s release" pellets.

Several commercial formulati are Agriform®, Mag-Am Osmocote®, Sulfurkote® and Green®. In addition to N-P-K, r tively small amounts of other ments are required for plant grow These are boron, calcium, cop iron, magnesium, mangane molybdenum, sulphur and zi Carbon, hydrogen and oxygen other essential elements.

Studies reported in this revie our research involved potting m ture, shape and size of contain basic fertilizer types and ra winter culture of pecan seedli and transplanting experiments v container-grown pecan nurs trees.

Potting Mixture

Based on his experience with ornamental nursery plant production and pecan nursery trees in containers, Dr. A. J. Laiche, Jr., Horticulturist at the South Mississippi Branch Experiment Station at Poplarville, developed an empirical formula (Bostian-Overcash Mixture, Table 1) in 1974 (3). It has served as a basically successful mixture for several experiments with pecan nursery trees in containers. (1,2,7,8,12,13,14,15,16). About 50% of the potting mixture is southern pine bark obtained from a pole-peeling mill. It is worked through a soil shredder until it can be screened through 1-inch mesh. This gives a mixture of bark sized from less than ⅛-inch to ⅞-inch diameter. This fraction of the potting mixture adds lightness and porosity to the mixture and provides adhesion for mineral additions.

Table 1. Preparation of the Bostian-Overcash potting mixture used i production of pecan nursery trees in a container size-fertilizer study, Mississippi State University, 1978.

14 cu ft pine bark (screened below 1 inch)
10 cu ft mason sand
3 cu ft good soil (preferably fumigated with methyl bromide or oth soil fumigants or steamed to 180°F for 30 minutes amd then allowed cool slowly)
Add following chemicals, then mix thoroughly to insure even distrib tion of chemicals and potting mixture:
4.4 lb Osmocote® 18-6-12 (8-9 months)
6.6 lb Dolomitic limestone (Ca-Mg)
2.2 lb 20% superphosphate
1.1 lb Calcium sulfate
.55 lb Iron sulfate
.14 lb Peter's Fritted Trace Elements® (FTE No. 503) (18% Fe, 7.5% Mn, 7% Zn, 3% B, 3% Cu, and .2% Mo)

About 38% of the mixture is coarse ason sand, the type commonly ed to make mortar for brick lay- g. The sand is a filler between the arse bark particles and provides lhesive surfaces for good drainage nd aeration.

The remainder of the potting ixture is silt or sandy loam soil, hich is added as a source of small nounts of mineral elements. It so is a filler between coarse pine ark particles and provides lhesive surfaces for mineral addi- ns to the mixture.

The pine bark and mason sand are relatively free of insect, disease or weed problems and are not fumigated. The soil is fumigated because of these problems. We steam fumigate the soil to 180°F for 30 minutes and then let it cool slowly. Proper use of MC²® (or other gaseous, solid or liquid fumigants) can effectively control pests.

Ingredients of the potting mixture are blended or mixed in a small electric concrete mixer or a commercial soil mixer or blender. The chemicals are added after the basic ingredients are partially blended. The iron sulfate and Peter's Fritted Trace Elements® are hand mixed with 1 gallon of moist sand and then added uniformly over the surface of the moving mixture. This precaution with the micronutrients is an effort to distribute the small quantities of these elements uniformly throughout the mixture. Mixing is continued for 15 minutes after the micronutrients are added. The potting mixture usually is prepared at the beginning of each experiment. The chemicals in the basic mixture sometimes are varied in research efforts to improve growth of pecan seedlings.

Experiments with Container Sizes Shapes and Fertilization

Evaluation of the long-held belief at nursery trees with long taproots 3 ft or more) are needed for suc- ssful establishment of pecan chards was triggered by the up- aval of mature pecan trees by rricanes such as "Camille" in uth Mississippi in 1969. The up- oted trees had been transplanted th long taproots but were blown er with relatively shallow root lls, and no strong, deep taproots re present.

We made a study of seedling pecan es grown in containers of various apes and sizes. The five container es selected for the study are strated in Figure 3 and described Table 2.

Figure 3. Average seedlings after one growing season in the nursery-container experiment. Containers are A, 3 x 24 inch; B, 4 x 24 inch; C, 6 x 24 inch; D, 10 x 20 inch; E, 10 x 10 inch.

Table 2. Dimensions of nursery containers used to produce pecan nursery seedlings in a container size-fertilizer study, Mississippi State University, 1978.

Code	Container	Height	Diameter Top	Diameter Bottom	Volume
		inches			gallons
A	3 inch PVC pipe	23.8	3.1	3.1	.8
B	4 inch flexible plastic sleeve	23.8	4.1	4.1	1.4
C	6 inch PVC pipe	23.8	6.0	6.0	3.0
D	6 gallon nursery can	19.9	10.2	8.6	5.9
E	3 gallon nursery can	10.2	9.9	9.6	2.9

Procedure

Nuts of the 'Stuart' cultivar were harvested in November 1977 and were stored dry at 40°F until March 1978. Nuts for planting were selected for uniformity at an average of 35/lb and were stratified by refrigeration in moist peat moss at 40°F until immediately before planting.

The eight- to nine-month type of 18-6-12 (N-P_2O_5-K_2O) Osmocote® was blended with Bostian-Overcash potting mixture at 4.4 lb per cubic yard of potting mixture (X rate), 6.6 (1.5 X rate) or 8.8 (2 X rate). The potting mixture with the X rate of Osmocote was poured into 80 containers of each shape and size, that with the 1.5 X rate into 40 containers of each shape and size and that with the 2 X rate into 40 containers of each shape and size. All containers were bumped to leave head space of 0.5 inch or more for watering. Three nuts were planted May 13, 1978 near the center of each container at a depth of twice the diameter of the nuts. The nuts were planted promptly after removal from stratification.

Seedling emergence was facilitated and seedling injury was prevented by moistening the surface of the growing medium when the seedlings started to emerge. Watering at that time and throughout the study was by hand. We used a water-breaker nozzle to reduce spatter of the potting mixture from the containers.

Seedlings in each container were thinned to the strongest if more than one emerged, and a healthy seedling was transplanted from another container if none emerged. The 160 containers were placed in full sun on a concrete floor of the greenhouse and plant-growing complex of the Mississippi State University Horticulture Department and were spaced equidistant and far enough apart to eliminate shading as a problem. The containers were supported by a frame constructed of 2 x 4-inch lumber, and spaces were subdivided into 10-inch segments by wood slats running across the width of the frame. Containers that would not stand independently (2 x 24-, 4 x 24- and 6 x 24-inch) were wired to the subdividing slats.

The surface of the mixture was kept moist throughout the study. Water was applied as needed, often daily in the absence of rain.

Fungicides and insecticides were supplied as needed to control diseases and insects.

One-half (40) of the containers filled with the potting mixture containing the X rate of Osmocote were fertilized with supplemental N-P-K, beginning 42 days after planting and once each week thereafter until September 24, 1978. A stock solution was made by mixi[ng] 2 lbs of water-soluble Peter['s] 20-20-20 (N-P_2O_5-K_2O) in 1 gallon [of] water. Part of the stock soluti[on] was diluted in 200 parts of wat[er] and two thirds of 1 pt of the dilut[ed] solution was applied each week.

Results

Trunk height and trunk diame[ter] at the surface of the potting mixtu[re] were greatest for seedlings gro[wn] in the standard 10 x 10-in[ch] 3-gallon nursery container (Ta[ble] 3). Taproot diameter at 4 inch[es] below the surface of the potti[ng] mixture was greatest in the 10 x [20] and 10-20-inch containers (Table [4]).

Overall performance (Tables [3] and 4) was poorest for seedlin[gs]

Table 3. Trunk height and trunk diameter at the surface of the potting mixture of pecan seedlings grown one season in a pine bark-sand-soil potting mixture, by size of nursery container, Mississippi State University, 1978.

Container size	Trunk height	Trunk diameter at surface
inches	inches	
3 x 24	8.9* D**	.28 D
4 x 24	9.5 CD	.33 C
6 x 24	10.0 C	.36 C
10 x 20	12.0 B	.42 B
10 x 10	13.5A	.46A

*Average of 8 replications of 4 fertilizer programs.
**Numbers in a column not sharing a letter in common differ significantly at the 5% level of probability as judged by Duncan's new multiple range test.

Table 4. Taproot diameter 4 inches below the surface of the potting mixture and trunk diameter 4 inches above the surface of the potting mixture of pecan seedlings grown one season in a pine bark-sand-soil mixture, by size of growth container, Mississippi State University, 1978.

Container size	Taproot diameter 4 inches below surface	Trunk diameter 4 inches above surface
inches	inches	
3 x 24	.41* E**	.18 C
4 x 24	.50 D	.21 B
6 x 24	.67 C	.22 B
10 x 20	.87 B	.30 A
10 x 10	1.09 A	.32 A

*Average of 4 replications of 4 fertilizer programs.

**Numbers in a column not sharing a letter in common differ significantly at the 5% level of probability as judged by Duncan's new multiple range test.

vn in the 3 x 24-inch plastic
s. Pecan seedlings grown in
ch pipes have been transplanted
essfully to an orchard where
grow well, but not as well as
lings from larger containers

ne X rate of Osmocote did not
ide enough NPK to sustain
imum growth throughout the
on, and average tree weight
only 4.4 oz (Table 5). The best
vth was by seedlings that receiv-
he X rate of Osmocote plus
plemental NPK.
edlings grown in the 10 x 10-
10 x 20-inch containers were
est, and those grown in 3 x 24-
4 x 24-inch containers were
llest (Table 5). Size of seedlings
vn in 6 x 24-inch containers
intermediate.

Table 5. Average fresh weight of dormant pecan seedlings after one growing season in a pine bark-sand-soil potting mixture, by size of growth container and fertilization rate, Mississippi State University, 1978.

Container size	Fertilization rate: X*	1.5X	2.0X	X + NPK**	Average
inches	oz				
3 x 24	2.6 fg***	3.2 efg	1.6 g	3.4 efg	2.7 C
4 x 24	2.0 fg	4.5 cdefg	3.1 efg	4.2 cdefg	3.5 BC
6 x 24	3.9 defg	5.3 bcdef	4.7 cdefg	4.7 cdefg	4.6 B
10 x 20	8.3 ab	7.3 abcd	7.7 abc	10.6 a	8.5 A
10 x 10	5.3 bcdef	6.5 bcde	8.4 ab	9.9 a	7.5 A
Average	4.4 E****	5.4 DE	5.1 E	6.6 D	

*Basic Osmocote® rate, 4.4 lbs per cubic yard.
**Basic Osmocote rate plus supplemental NPK applied once each week, beginning 42 days fter planting.
***Means within a column not sharing a letter in common differ ($P < .05$) as judged by Duncan's new multiple range test.
****Means not sharing a letter in common differ ($P<.05$) as judged by Duncan's new multiple range test.

Osmocote Monthly Supplement Experiment

hiform nuts of 'Cape Fear' were
cted in November 1980 and
tified from December 18 to
uary 10, 1981. They were then
ted in 1-gallon nursery con-
ers (three per container) using
asic Bostian-Overcash potting
ure (3).
e containers were kept in the
nhouse at 65°F or higher until
130. They were then transplant-
3-gallon containers with the
e potting mixture and trans-
d to an outdoor concrete floor
50% shade.
hiform seedlings were selected
fertilizer supplement study.
teen one-tree replicates were
. A no supplemental fertilizer
k and four supplemental ferti-
rates ranging from 0.14 to 4.44
f Osmocote 18-6-12/3-gallon
ainer were used at monthly
vals from May through August.
e plants were transferred June
an outdoor concrete floor and
ed 2 ft between plants. They
were watered as needed at one- or two-day intervals. The pH analyses of potting mixture in July indicated 6.0 to 6.7, which is within the desirable range. At the end of the growing season five plants from each fertilizer treatment were washed clean, and the weights of the roots (below surface) and trunks were recorded (Table 6). The root constituted 84% of the total plant weight.

The supplemental fertilizer rates were selected in an effort to range up to the toxic level. No differences in trunk size between treatments were significant ($P< .05$). Responses to no supplement and to .14 oz of Osmocote monthly did not differ. The best root growth followed monthly treatment with 0.44 oz or 1.41 oz. The highest rate of Osmocote retarded growth of the seedlings.

Table 6. Fresh weights of container-grown 'Cape Fear' pecan seedlings after one season of growth in Bostian-Overcash potting mixture supplemented monthly with Osmocote® 18-6-12, by rate of fertilizer application.

Osmocote applied monthly	Total plant	Roots	Trunk
	oz		
0.00	10.4ab	8.7 bc	1.7a
0.14	9.3 bc	7.8 cd	1.5a
0.44	13.0a	11.1a	1.9a
1.41	12.6a	10.5ab	2.1a
4.44	7.3 c	6.0 d	1.3a

Mean separation in columns by SNK at $P < 0.05$. Means in a column not followed by the same letter are statistically different.

Day Length and Growth of Pecan Seedlings

earchers have shown that
plants can be grown from
nuts, and that the trunks can be large enough to bud in a few months. The application of gibberellic acid (GA) to a small trunk accelerates

its growth and makes budding feasible at an earlier date.

Our experiment explored the feasibility of growing seedlings in a greenhouse in winter. Day lengths and GA stem applications were included because pecan trees appear to thrive during long summer days or long natural photoperiods.

Nuts were harvested in November 1973 and stratified in moist peat moss at 40°F from December 1973 to September 1974 (3). They were planted in 3 x 12-inch plastic pipes containing Bostian-Overcash potting mixture. Seedlings emerged by October 3 and made good growth.

All plants received eight hours of natural daylight (8 am to 4 pm daily). Supplemental light (100 watt incandescent bulbs maintaining 50 foot candles at seedling level) was used for either eight or 16 hours daily. Plants were spaced 6 x 8 inches in cages covered with black cloth as needed to restrict day length periods to eight, 16 or 24 hours of illumination.

The GA was applied as the potassium salt prepared as a 5000 ppm solution in water and was mixed mechanically 1:2 (v/v) with USP lanolin to form a paste. The GA-lanolin paste application was centered around the trunk in a 1-inch band at 1 inch above the potting mixture surface. The lanolin kept the GA in place, and the trunks subsequently enlarged rapidly. Four applications were made, one each week beginning October 3.

Each increase in length of daily light period with or without GA application increased trunk height and numbers of leaves per plant (Table 7). Differences in height and numbers of leaves per plant due to GA treatment were slight. Trunk cross-sectional area was least for the shortest daily photoperiod b was increased appreciably by G treatment in each photoperi group.

Treatment of stems of you pecan seedlings with GA in a lano paste can produce stems lar enough to bud or graft earlier th is possible without treatment. U of longer daily photoperiods (16 24 hours duration with 50 f candles at plant height) makes possible to grow seedling pec plants during the winter to s ficient size for budding in late win or grafting in early spring.

Table 7. Plant height, numbers of leaves per plant and trunk cross-sectional area of pecan seedlings grown in 3 x 12-inch plastic pipes containing Bostian-Overcash potting mixture, by length of daily photoperiod, with and without gibberellic acid (GA) treatment[1].

Photoperiod daily	Height		Leaves/plant		Trunk cross section*	
	GA	none	GA	none	GA	none
hours	------inches------		-----number------			
8	8.4 c**	6.7 c	8.8 b	7.4 c	.93 b	.34a
16	10.8 b	10.9 b	9.9a	9.0 b	1.23a	.32a
24	12.6a	13.7a	9.4 a	10.1a	1.22a	.24
Average	10.6	10.4	9.4	8.8	1.13	.30

[1]Seed planted September 18, 1974 and grown until December 15 in a greenhous at 65-85°F.
*Calculated as a fraction of 1/4 sq. in.
**Means in a column not followed by the same letter are significantly different at .05 level.

Pecan Nursery Tree Transplanting Experiment

Nursery trees in containers have been transplanted to orchards readily, with unusually good liveability and subsequent growth (8, 12, 14). An experiment was established in 1974 on a Savannah sandy soil at Poplarville, Mississippi to study the influence of several preplant treatments on growth of trees for two years (12).

One-year-old seedlings that had been grown in 2-gallon nursery containers were included. Seedlings with taproots coiled around the inside of the container were used. One half of the taproot was removed from seedlings in one treatment for comparison of growth with that of seedlings that were not root pruned. The seedlings that were not root pruned weighed about 30% more than pruned trees after two years. Trees that were not root pruned also had larger primary roots and larger trunk diameters at 12 inches above the soil. Primary root diameters at 18 and 24 inches below the soil surface, two years after transplanting, were 80 and 160% larger, respectively, for trees that were not root-pruned.

Other treatments involved root pruning (one half of length remov of the taproot of barerooted nurs trees. These trees lived and g well but generally were somew smaller in subsequent years t where the whole taproot planted. Small nursery trees wi ft-long taproots were establis by removing all side roots and pl ing in a 1½-inch diameter bored with a soil auger. These t all lived and grew satisfacto but not as well as trees plan differently.

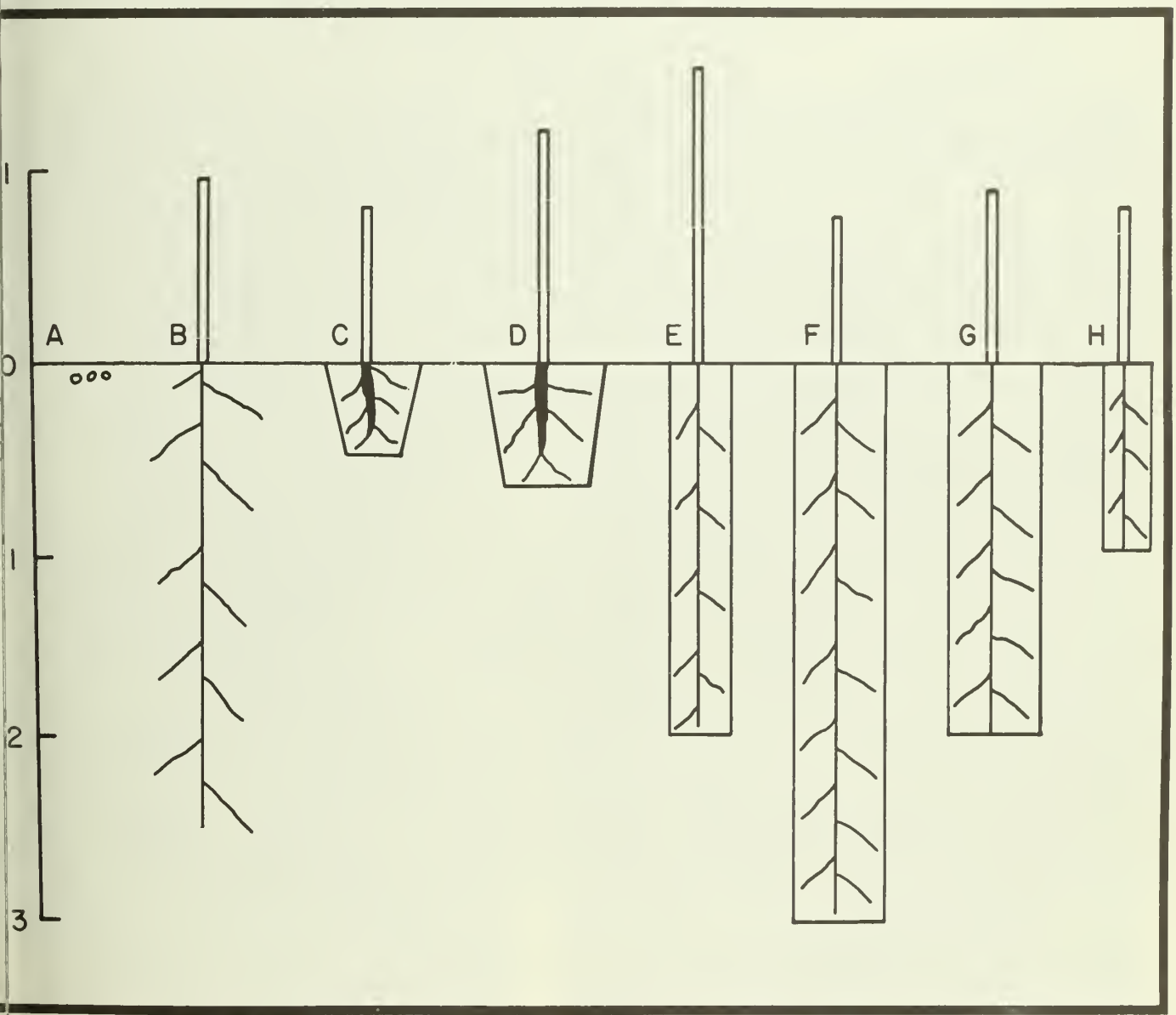
Another experiment invol planting nuts in the orchard, b

ot planting of seedlings with 30 ch taproots and planting seedgs grown in six different types of ntainers (Figure 4). Seedlings nerging from the planted nuts ere thinned to the strongest. Seedgs were removed from the coniners and planted in holes dug ghtly larger than the respective ntainers.

One half of the trees (four replites) were trickle irrigated as eded to maintain optimum growth, with one emitter per tree at eight inches from the trunk the first two years and two emitters per tree at 12 inches from the trunk thereafter. Weeds were controlled manually, and the middles were disked the first year. A 4-ft wide weed-free band was maintained along the tree row by use of herbicides (paraquat, diuron and Roundup®) as needed after the first year. Native grasses formed a sod the second year, and this was mowed at two-week intervals.

The trees were maintained in the orchard for five years, and measurements were made annually. Branching was controlled by removing undesirable scaffold limbs when they were small and developing a central leader trunk where feasible. Trunk cross-sectional area often has been correlated closely to total tree top.

Irrigation had a profound influence on pecan tree growth (Table



e 4. Diagram of pre-transplanting treatments in the pecan nursery tree transplanting experiment. Treatments are A, seed; B, bare rooted; C, 6-quart nursery iner; D, 8-quart nursery container; E, 4 x 24-inch plastic tube; F, 6 x 36-inch plastic pipe; G, 6 x 24-inch plastic pipe; H, 3 x 12-inch plastic pipe..

8 and Figure 5). The average increase in trunk cross-section area was 77%. Trees from 2-gallon containers that were irrigated had almost a 100% gain in cross-section area. Nursery trees from the 2-gallon containers, 4 x 24-inch plastic sleeves and 6 x 24-inch pipes had the largest trunks. Barerooted trees transplanted with taproots 2.5 ft long had the smallest trunks after five years, except for the trees grown

Table 8. Trunk cross section and total length of branches of pecan seedlings grown in an orchard for five years, by method of planting, with and without irrigation.

Treatment	Trunk cross section*			Length of branches		
	Check	Irrig.	Av.	Check	Irrig.	Av.
	sq inch			linear ft		
2 gallon can	6.3	12.4	9.4A**	121	156	138A
4 x 24 inch sleeve	6.1	11.8	8.9A	74	163	118 B
6 x 24 inch pipe	6.7	9.8	8.3A	96	99	97 B
1.5 gallon can	4.9	9.3	7.1 B	56	116	86
6 x 36 inch pipe	4.0	9.1	6.6 B	65	104	84
Bare root	4.8	6.7	5.8 C	63	94	78
3 x 12 inch pipe	5.6	9.1	7.4 B	56	87	71
Nuts planted in orchard	3.1	5.4	4.3 D	32	50	41
Average	5.2	9.2		70	110	

*Measured at 24 inches above orchard floor.
**Means in a column not sharing a letter in common differ significantly (P<
as judged by Duncan's new multiple range test.

Figure 5. Pecan trees five years after transplanting to the orchard. Trees were grown in 2-gallon containers for one year before transplanting. Tree on left was irrigated and tree on right was not.

m seed, which were a year nger (Figure 6).

'otal length of branches also is a od criterion for tree size. Trees m 2-gallon containers had the st branch growth, and trees from x 12-inch pipes had the least wth, except for trees from nuts nted directly in the orchard. Five-ar-old orchard trees from several tainers were substantially larger n trees from seedlings that were nsplanted barerooted.

Trees from 2-gallon containers were larger than those from 1.5-gallon containers. These differences were maintained year-after-year. Direct-seeded trees remained smaller than all others, and these trees had trunk cross section and total length of branches less than one half that of trees from 2-gallon containers.

No logical explanation has been found for better growth of trees from 6 x 24-inch pipes than that from 6 x 36-inch pipes. The results of this test clearly show that a pecan tree can be established under orchard conditions from trees grown in various shapes and sizes of containers. Trees from the smallest container (3 x 12 inch) were successfully established and made good growth, but not nearly as much as that from larger containers (e.g., 2 gallon).

re 6. Pecan seedling trees after five years in the orchard. Tree on left was grown from a barerooted nursery tree with a 30-inch taproot. Tree on right was grown ace from a nut planted when the barerooted tree was set in the orchard.

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'Cape Fear' pecan trees with two-year-old roots and one-year-old scions in October and February (diameter of containers is 10 inches).

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The Influence of Winter Vegetation on Seedbed Preparation and Weed Control in Cotton

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The Influence of Winter Vegetation on Seedbed Preparation and Weed Control in Cotton

Experiments have demonstrated benefits from the use of winter cover crops (2). These are added nitrogen from a legume, improved soil tilth as a result of the additional organic material and "buffering" of herbicides due to the added organic material near the soil surface. One major disadvantage from using winter cover crops in the production of cotton is that the turned-under green vegetation often does not have time to decompose properly before time to plant cotton. Management of vegetative cover in the spring is especially critical in areas where cotton is planted on beds, because obtaining a good stand may require rainfall to "settle" the beds before planting. Studies also have shown economic benefits from yearly fall subsoiling of soils usually selected for cotton production in the Delta of Mississippi (3,4). The combination of fall practices, such as stalk destruction, subsoiling and seeding a winter cover crop, often is hampered severely by the normal rainfall pattern in the mid-South.

Studies were initiated in the fall of 1977 with the objective of evaluating the influence of winter cover crops on seedbed preparation and cotton yield and on the application and performance of selected herbicides.

Materials and Methods

Split plot experiments with four replications were conducted for five years (1978-82) on a Bosket silt loam soil at Stoneville, Miss. Main plots treatments were wheat, vetch and winter weeds (a conventional treatment) as cover crops. Main plots were 20 rows, 40 inches wide by 40 feet long. Wheat and vetch were seeded with a hand-carried rotary seeder near the time of defoliation each year. The wheat and vetch seed did not germinate in 1978 and 1979, and the plots were disked lightly shortly after cotton harvest to enable the seed to germinate.

The four-row subplots were a non-herbicide check and application of (1) Roundup® (glyphosate) at 1.34 lbs a.i./acre applied to the cover crop (PPF) and Cotoran® (fluometuron) at 1.5 lbs a.i./acre preemergence (PRE); (2) Roundup applied PPF, Treflan® (trifluralin) at 0.75 lbs a.i./acre applied to the seedbed and soil incorporated shallow (PPI) and Cotoran PRE; (3) Cotoran PRE and (4) Treflan PPI followed by Cotoran PRE. Plots were maintained in the same location each year. The PPI treatments were soil incorporated with a rolling cultivator in 1978, 1979 and 1981, and with a bed conditioner in 1980 and 1982.

The entire area was subsoiled with a parabolic subsoiler each winter at 45° to the old rows. This practice was estimated to disturb about 50% of the soil surface area. It also was estimated that this activity reduced the cover crop stand by 50%. The recommended amount of fertilizer (80 to 120 lbs nitrogen/acre/yr as a urea-ammonium nitrate solution) was knifed into the soil on 20-inch centers over the entire area at or near the time of bedding. Control of insects and diseases was accomplished with recommended practices. Details of seedbed preparation and production operations are listed in Table 1.

All PPF, PPI and PRE herbicides were applied broadcast in water at 20 gal/acre, using a tractor-mounted boom sprayer. Postemergence herbicides were applied in water at 20 gal/acre broadcast volume to a 20-inch band centered on the row, using a cultivator equipped with spray shields and two nozzles per row. Over-the-top (OT) treatments (1980, 1981) were applied broadcast as described above.

Postemergence herbicides and broadcast rates were Probe® (methazole) at 0.75 lb a.i./acre + MSMA at 2.0 lbs a.i./acre in 1978; Probe at 0.75 lb a.i./acre + MSMA at 2.0 lbs a.i./acre and Caparol® (prometryn) at 0.5 lb a.i./acre + MSMA at 2.0 lb a.i./acre in 1979; RO 13-8895 at 0.375 lb a.i./acre (OT to Treatment 1 only) and Premerge® (dinoseb) at 1.5 lbs a.i./acre in 1980; MSMA at 2.0 lbs a.i./acre (Treatment 1 only), Poast® (sethoxydim) at 0.25 lb a.i./acre (OT) and Premerge at 1.5 lbs a.i./acre in 1981 and Premerge at 1.5 lbs a.i./acre + MSMA at 2.0 lbs a.i./acre and Premerge at 1.5 lbs a.i./acre in 1982.

Estimates of winter vegetation were made in April, 1978-81 and in November, 1981 by counting individual plants by species on five 1-by-3-ft areas randomly placed within each main plot. All vegetative plant material above the soil line in randomly selected 1-by-3-ft areas was removed by hand each spring to estimate the amount of plant residue for each cover crop area. These samples were dried to a

constant weight in a forced air drier at 120° F, and the dry weight per acre was calculated.

Beds were formed with a conventional four-row disk hipper on the indicated dates (Table 1). The experiment was drill planted to 'DES 56' cotton with a John Deere 7100® four-row planter. All row middles were cultivated on the dates indicated with a two- or four-row cultivator equipped with spray shields positioned 9 inches from either side of the drill row.

Cotton stand was determined by counting plants from one row in each plot. Plants per acre were calculated from these counts. Evaluation of summer weed control was made by counting weed plants by species and by determining the hoe time required to remove summer weeds. Weed counts were made two or three weeks after cotton emergence on two randomly selected 1-x-3-ft areas centered on row two of each plot. These counts were combined are reported as plants per 6 s The time required to hoe the center rows of each plot determined five to six weeks a cotton emergence and is repo as hours per acre.

Cotton yield was determine harvesting the two center row each plot with a spindle pi adapted to harvest small plots. yields were converted to poun seed cotton per acre.

Results and Discussion

No advantage in seedbed preparation was observed when Roundup was applied to the cover crops (Subplot Treatments 2 and 3) before beds were formed. This may have been caused by the 50% reduction in winter vegetation that resulted from the subsoiling operation. Wheat and winter weed plants were dead from the Roundup treatments when beds were formed, even though only five to 23 days elapsed from the time of application of Roundup until hipping (Table 1). Vetch plants were suppressed (no new growth after Roundup application) and were "off-color". Areas treated with Roundup and those not treated had no living plants at planting.

The cover-crop residue did not interfere with bedding, planting or herbicide application. The incorporation operation with the bed conditioner was not affected by wheat and vetch residue, but considerable time was lost removing trash from the tines of the rolling cultivator.

Total green weights of winter vegetation in April ranged from 1.7 tons/acre in 1980 to 7.0 tons/acre in 1979 for wheat, from 2.7 tons/acre in 1980 to 6.7 tons/acre in 1979 for vetch and from 0.6 tons/acre in 1982 to 1.7 tons/acre in 1981 for winter weeds. Total dry weights ranged from 0.54 to 1.42 tons/acre for wheat, 0.57 to 1.31 tons/acre for vetch and 0.30 to 0.70 tons/acre for winter weeds (Table 2).

The predominant winter weed on all cover crop areas in 1978, 1979 and 1980 (Table 2) was hairy bittercress (*Cardamine hirsuta* L.). Henbit (*Lamium amplexicaule* L.) replaced bittercress as the predominant species in 1981 (both spring and fall), but bittercress plants still were present in large numbers. This was probably due to specific environmental conditions favoring henbit. The herbicide treatments changed neither the species composition nor the weight of subsequent winter vegetation in this study.

Cotton stands were higher in the winter weed plots each year and were significantly higher than in the wheat and vetch plots in three of the five years (Table 3). The five-year average cotton stand was highest on the winter weed plots, stands following wheat were significantly less than those following winter weeds, and stands following vetch were significantly less than those following wheat or winter weeds. No logical explanation can be given for these differences because field observation indicated no differential influence on stand from insects or seedling disease. It appears that the low stands for wheat in 1978 and for vetch in 1982 contributed to the low cotton yields on these areas (Table 4).

Cotton stands averaged over the five years were not affected by herbicide treatment (Table 3).

The three cover crops did not affect the hoe time require remove summer weeds from (Table 5). All herbicide treatm required less hoe time than di check (bed only), but no signif differences (four-year aver occurred among individual h cide treatments.

Populations of redroot pig (*Amaranthus retroflexus L).*, pr sida (*Sida spinosa* L.) and an grasses---broadleaf signalg (*Brachiaria platyphylla* (Gr Nash), barnyardgrass (*Echino crusgalli* (L.) Beauv.) and brow panicum (*Panicum fasciculi* Sw. var. *reticulatum* (Torr.) Be were not statistically different fo ing any cover crop (Table 6). 1981 and four-year average po tions of annual morningg "(pitted (*Ipomoea lacunosa* L. leaf (*I. hederacea* (L.) Jacq.) entireleaf (*I. hederacea* var. *integriuscula* Gray)" were h following vetch (Table 6). No an morningglory plants were obs in 1979. Populations of redroo weed on all herbicide-treated were lower than for the check only) except for 1981, an morningglory populations lower in two of four years prickly sida populations were l in three of five years. The 1980 and 1981 and the five average populations of an grasses were lower on herbi treated plots than on the check annual grass population in

Table 1. Production operations used in a study of the influence of winter cover crops on seedbed preparation and cotton yield and on the application and performance of selected herbicides, MAFES Delta Branch, 1977-1982.

Operation	1977	1978	1979	1980	1981	1982
	(month/day)					
Cut stalks	9/6	10/16	12/3	10/23	10/16	--
Disk	10/17 (2)	10/26	--	--	--	--
Disk	10/28	--	--	--	--	--
Subsoil	--	10/26	12/5	12/4	--	3/12/82
Glyphosate[1]	--	4/14	4/17	4/24	4/22	4/27
Wheat height (in.)	--	(15)	(24)	(16)	(36)	(24)
Vetch height (in.)	--	(18)	(20)	(18)	(20)	(12)
Winter Weeds height (in.)	--	(10)	(8)	(10)	(12)	(10)
Lip	--	4/19	5/10 (2)	5/6	4/28 (2)	5/5 (2)
Lehip						
(Early)	--	--	5/10	--	--	--
(For planting)	--	5/15	5/16	5/29 (2)	5/11	5/18 (2)
Herbicide Incorporation						
Rolling Cultivator	--	5/15	5/16	--	5/11	--
Bed Conditioner	--	--	--	5/29	--	5/18
Plant 'DES 56'	--	5/16	5/17	5/30	5/11	5/18
Postemergence Herbicides						
1st Directed application	--	6/14	6/11	7/1	6/4[3]	7/6
Cotton height (in.)	--	(5-8)	(4)	(8-12)	(2-5)	(8-20)
2nd Directed application	--	6/27	6/27	--	6/23	7/15
Cotton height (in.)	--	(10-14)	(8-11)	--	(7-10)	(12-24)
Over-the-top Application	--	--	--	6/18[2]	6/19	--
Cotton height (in.)	--	--	--	(3-5)	(7-10)	--
Cultivations						
1st	--	6/13	6/11	6/18	6/2	6/1
2nd	--	6/14	6/27	7/3	6/4	6/15
3rd	--	6/24	--	7/30	6/15	6/25
4th	--	--	--	--	6/23	7/6
5th	--	--	--	--	6/30	7/15
6th	--	--	--	--	7/14	--
Dope	--	6/30	6/5	7/25	7/6	--
	--	--	--	--	8/4	--
Defoliate	--	9/18	10/11	9/30	9/25	9/15
Harvest	--	9/29	11/6	10/15	10/6	10/18
	--	--	11/19	--	--	--

[1] Applied to subplot treatments 2 and 3 only at 1.34 lbs a.i./A (see Table 3).
[2] Applied grass herbicide; to treatment 1 only in 1980 and to all treatments in 1981.
[3] Applied only MSMA to treatment 1 in 1981.

was reduced with treatments of Treflan PPI followed by Cotoran PRE but not with Cotoran PRE. Annual counts of grass plants did not differ when Treflan was incorporated with a rolling cultivator (1978, 1979, 1981) or a bed conditioner (1980, 1982). This is in agreement with Alston, et al.(1).

The only significant cover crop by herbicide treatment interaction effect on annual grass control occurred in 1982 (Table 7). The annual grass population when no herbicides were used was largest when wheat was the winter cover crop.

Significant cover crop by herbicide treatment interaction effects on seed cotton yields occurred in 1979, 1982 and the five-year average. All herbicide treatments in 1979 resulted in higher yields with wheat as the cover crop than from the check (Table 8).

Yields from herbicide-treated vetch cover-crop plots in 1982 were lower than from wheat or winter weeds except for the Roundup®-bed-Treflan®-Cotoran® treatment (Table 9). Yields following all herbicide treatments were higher than from plots where herbicides were not applied.

The 1978-1982 average yields were higher from herbicide-treated plots than from plots where herbicides

were not applied (Table 10). The highest five-year average yield from the check (no herbicides) was from plots where winter weeds were the cover crop. The highest five-year average yield was from the Roundup-bed-Treflan-Cotoran plots.

Summary

Cotton was grown after three cover crops (wheat, vetch, winter weeds) for five years (1978-1982). The winter vegetation was characterized by indigenous species and was not altered by the herbicide treatments used. The winter vegetation did not interfere with bedding or planting operations, but the residue from wheat and vetch greatly interfered with soil incorporation of herbicides when using a rolling cultivator. Preplant application of Roundup® to the cover crops did not make it easier to perform subsequent preplant tillage operations. The composition and control of summer weeds were not affected by the cover crops.

All herbicide treatments provided acceptable control of sum[illegible] weeds. Seed cotton yield was [illegible] affected consistently by the ty[illegible] winter cover, but yield after e[illegible] cover crop was greatest follow[illegible] the most intensive applicatio[illegible] herbicides (Roundup, Treflan, [illegible] oran).

Table 2. Effect of winter cover crops and production operations on the composition and yield of winter vegetation on plots used to grow cotton with the production operations presented in Table 1, MAFES Delta Branch, 1978-1982.

		Winter Vegetation									
		Number of plants/15 square feet									
Cover		1978	1979	1980	1981		Total dry weight when harvested on				
Crop	Weed	April	April	April	April	Nov.	4/4/78	4/16/79	4/20/80	3/30/81	5/3/82
							(tons/acre)				
Wheat											
		54.9	76.5	75.5	236.0	173.0	0.55	1.42	0.54	1.10	0.91
	Annual bluegrass	9.5	4.5	12.5	7.5	55.7					
	Common chickweed	0.5	0	7.5	0	30.1					
	Cutleaf eveningprimrose	0	0	2.5	0	0					
	Hairy bittercress	47.5	51.0	86.5	4.4	81.6					
	Henbit	2.5	1.5	23.5	68.1	190.5					
	Mouseear chickweed	0	0	0	10.0	0					
	Mousetail	0	0	4.5	6.9	24.1					
	Water foxtail	0	0	0.5	0.4	0					
	Speedwell	5.5	19.0	58.0	15.0	19.0					
Vetch		20.5	68.5	70.5	30.4	112.1	0.57	1.31	0.70	0.66	1.18
	Annual bluegrass	31.5	12.0	18.5	12.5	60.0					
	Common chickweed	1.0	0	7.5	0	120.5					
	Cutleaf eveningprimrose	0	0.1	1.0	0	0					
	Hairy bittercress	149.0	122.5	94.0	7.5	75.7					
	Henbit	12.5	9.5	34.5	82.3	436.2					
	Mouseear chickweed	0	0	0	41.3	0					
	Mousetail	0	0	9.5	4.4	35.1					
	Water foxtail	0	0	0	1.5	2.5					
	Speedwell	6.0	31.5	69.5	12.5	46.5					
Winter Weeds Only		--	--	--	--	--	0.30	0.48	0.40	0.50	0.70
	Annual bluegrass	14.0	22.5	32.0	24.8	180.6					
	Common chickweed	0	0	11.5	0	83.0					
	Cutleaf eveningprimrose	0	1.5	1.5	0	0					
	Hairy bittercress	174.0	293.5	62.0	9.4	134.6					
	Henbit	8.5	4.0	33.5	63.5	387.1					
	Mouseear chickweed	0	0	0	17.3	0					
	Mousetail	0	0	9.5	7.9	88.2					
	Water foxtail	0	0	21.0	10.4	0					
	Speedwell	15.0	93.5	124.0	22.5	65.5					

Table 3. Effect of winter cover crops and production operations on stands of cotton, MAFES Delta Branch, 1978-1982.

Item	Cotton Stand 1978	1979	1980	1981	1982	5-Year Avg.
	(Plants/A in thousands)					
Main-Plot Treatments[1]						
A. Wheat	21.5 b	65.0 b	42.9 a	56.2 b	35.0 b	44.1 b
B. Vetch	31.0 a	54.8 c	38.9 a	41.9 c	25.3 c	38.4 c
C. Winter Weeds	32.3 a	80.6 a	44.2 a	64.5 a	43.9 a	53.1 a
Subplot Treatments[1]						
1. Bed only	26.2 a	65.5 a	43.8 a	52.5 a	32.7 c	44.1 a
2. Roundup PPF Bed Cotoran PRE	26.9 a	65.3 a	44.8 a	57.0 a	39.3 a	46.7 a
3. Roundup PPF Bed Treflan PPI Cotoran PRE	30.0 a	62.9 a	41.5 a	56.4 a	37.2 ab	45.6 a
4. Bed Cotoran PRE	26.9 a	70.6 a	41.0 a	51.5 a	33.8 bc	44.8 a
5. Bed Treflan PPI Cotoran PRE	31.2 a	69.6 a	39.0 a	53.6 a	30.7 c	44.8 a

[1]Means within columns followed by the same letter are not different (P=.05) according to DMRT. PPF = preplant to cover-crop foliage; PPI = preplant incorporated shallow; PRE= preemergence.

Table 4. Effect of winter cover crops and production practices on seed cotton yield, MAFES Delta Branch, 1978-1982.

Item	Seed Cotton Yield 1978	1979[2]	1980	1981	1982[2]	5-Year Avg.[2]
	(lbs/A)					
Main-Plot Treatments[1]						
A. Wheat	1088 c	2242	1443 a	1559 a	1431	1552
B. Vetch	1494 b	1796	1439 a	1565 a	889	1437
C. Winter Weeds	1905 a	1968	1469 a	1751 a	1458	1710
Subplot Treatments[1]						
1. Bed only	1006 c	1615	1301 c	1316 b	219	1091
2. Roundup PPF Bed Cotoran PRE	1542 ab	2060	1480 ab	1734 a	1350	1634
3. Roundup PPF Bed Treflan PPI Cotoran PRE	1789 a	2099	1579 a	1721 a	1657	1769
4. Bed Cotoran PRE	1487 b	2107	1356 bc	1689 a	1389	1606
5. Bed Treflan PPI Cotoran PRE	1654 ab	2131	1536 a	1665 a	1683	1734

[1]Means within columns followed by the same letter are not different (P=.05) according to DMRT. PPF = preplant to cover-crop foliage; PPI = preplant incorporated shallow; PRE = preemergence.
[2]A significant cover crop x herbicide treatment interaction; see Tables 8-10 for mean separation.

Table 5. Effect of winter cover crops and production operations on summer weed control as determined by hoe time required to remove weeds from plots, MAFES Delta Branch, 1978-1981.

Item	Hoe Time 1978	1979	1980	1981	4-Year Avg.
	(Hr/A)				
Main-Plot Treatments[1]					
A. Wheat	8.7 a	29.8 a	45.4 a	7.7 a	22.9 a
B. Vetch	13.0 a	44.5 a	48.0 a	6.5 a	28.0 a
C. Winter Weeds	10.6 a	28.7 a	41.5 a	5.2 a	21.5 a
Subplot Treatments[1]					
1. Bed only	21.9 a	75.9 a	66.3 a	17.6 a	45.4 a
2. Roundup PPF Bed Cotoran PRE	9.4 bc	29.3 b	49.3 a	3.8 b	22.7 b
3. Roundup PPF Bed Treflan PPI Cotoran PRE	5.7 c	32.2 b	27.4 b	2.8 b	17.0 b
4. Bed Cotoran PRE	11.4 b	11.3 b	58.7 ac	4.8 b	21.6 b
5. Bed Treflan PPI Cotoran PRE	5.8 c	23.8 b	23.1 b	3.3 b	14.0 b

[1]Means within columns followed by the same letter are not different (P=.05) according to DMRT. PPF = preplant to cover crop foliage; PPI = preplant incorporated shallow; PRE = preemergence.

Table 6. Effect of winter cover crops and production operations on summer weed control as determined by weed counts, by weed species, MAFES Delta Branch, 1978-1982.

	All Morningglory[1,3] 1978	1979	1980	1981	1982	4-Year Average	Redroot Pigweed[2,3] 1978	1979	1980	1981	1982	4-Year Average
	(No./6 sq. ft.)						(No./6 sq. ft.)					
Main-Plot Treatments												
A. Wheat	9.7[3]	--	1.8	0.5 b	2.0 a	2.8 b	16.3	2.5	--	0.2	0.4	4.9
B. Vetch	12.4	--	3.1	1.5 a	5.4 a	7.8 a	17.6	1.2	--	0.5	0.2	4.9
C. Winter Weeds	5.7	--	3.1	0.4 b	4.7 a	4.1 b	22.0	2.7	--	0.2	0.1	6.3
Subplot Treatments												
1. Bed only	13.4	--	4.1	2.2 a	14.5 a	8.6 a	45.2 a	14.2 a	--	1.0 a	1.0 a	15.4 a
2. Roundup PPF Bed Cotoran PRE	8.6	--	2.3	0.6 b	2.3 b	3.5 b	19.4 b	1.8 b	--	0.0 b	0.0 b	5.3 b
3. Roundup PPF Bed Treflan PPI Cotoran PRE	6.6	--	1.4	0.5 b	1.1 b	2.4 b	5.5 b	0.3 b	--	0.6 ab	0.0 b	1.6 b
4. Bed Cotoran PRE	13.8	--	2.1	0.3 b	1.4 b	4.4 b	20.0 b	2.2 b	--	0.0 b	0.0 b	5.6 b
5. Bed Treflan PPI Cotoran PRE	3.9	--	1.2	0.5 b	0.6 b	1.6 b	3.0 b	0.4 b	--	0.0 b	0.0 b	0.9 b

	Prickly Sida[3] 1978	1979	1980	1981	1982	5-Year Average	Annual Grasses[3] 1978	1979	1980	1981	1982[4]	5-Year Average
	(No./6 sq. ft.)						(No./6 sq. ft.)					
Main-Plot Treatments												
A. Wheat	11.7	3.1	0.4	5.7	1.1	4.4	11.2	66.0	2.4	11.7	26.1	23.5
B. Vetch	8.4	4.2	0.5	8.5	0.8	4.5	15.5	35.8	7.0	6.8	13.6	15.7
C. Winter Weeds	12.9	5.2	0.4	5.2	0.2	2.5	36.1	37.3	7.6	9.9	13.7	20.9
Subplot Treatments												
1. Bed only	19.7	9.3 a	0.9	22.8 a	3.4 a	11.2 a	44.9 a	143.8 a	21.2 a	45.9 a	73.4	65.8 a
2. Roundup PPF Bed Cotoran PRE	7.0	3.3 b	0.3	6.7 b	0.0 b	3.5 b	48.9 a	30.4 b	3.7 b	1.3 b	5.0	17.9 b
3. Roundup PPF Bed Treflan PPI Cotoran PRE	11.5	2.4 b	0.2	0.7 b	0.0 b	3.0 b	4.6 b	7.5 b	0.2 b	0.4 b	1.4	2.8 b
4. Bed Cotoran PRE	8.7	3.9 b	0.5	1.4 b	0.0 b	2.9 b	28.8 ab	47.5 b	2.8 b	0.8 b	7.3	17.4 b
5. Bed Treflan PPI Cotoran PRE	8.1	1.7 b	0.2	0.8 b	0.0 b	2.2 b	3.6 b	2.6 b	0.3 b	0.1 b	1.9	1.7 b

[1]No morningglory present in 1979.
[2]No redroot pigweed present in 1980.
[3]Means within columns for main-plot treatments and subplot treatments followed by the same letter are not different according to DMRT. PPF = preplant to cover-crop foliage; PPI = preplant incorporated shallow; PRE = preemergence.
[4]A significant cover crop x herbicide interaction; see Table 7 for mean separation.

Table 7. Effect of winter cover crops and herbicide treatments on annual grass control on plots used to grow cotton with the production operations presented in Table 1, MAFES Delta Branch, 1982.

	Herbicide Treatment				
Cover Crop	1. Bed only	2. Roundup Bed - Cotoran	3. Roundup Bed - Treflan - Cotoran	4. Bed - Cotoran	5. Bed - Treflan - Cotoran
	(No. plants/6 sq. ft.)				
A. Wheat	111.8 a A	5.0 a B	1.5 a B	7.3 a B	5.0 a B
B. Vetch	52.5 b A	7.0 a B	2.8 a B	5.5 a B	0.3 a B
C. Winter Weeds	56.0 b A	3.0 a B	0.0 a B	9.0 a B	0.5 a B

[1]Means within columns followed by the same lower case letter or within rows followed by the same capital letter are not different (P = 0.05) according to DMRT.

Table 8. Effect of winter cover crops and herbicide treatments on seed cotton yield from plots used to grow cotton with the production operations presented in Table 1, MAFES Delta Branch, 1979.

	Herbicide Treatment				
Cover Crop	1. Bed only	2. Roundup Bed - Cotoran	3. Roundup Bed - Treflan - Cotoran	4. Bed - Cotoran	5. Bed - Treflan - Cotoran
	(lbs/A)				
A. Wheat	1482 b B	2601 a A	2663 a A	2691 a A	2732 a A
B. Vetch	1785 abA	2001 b A	2234 a A	2042 b B	2156 b A
C. Winter Weeds	2087 a A	2217 abA	2099 a A	2275 abA	2258 abA

[1]Means within columns followed by the same lower case letter or within rows followed by the same capital letter are not different (P=0.05) according to DMRT.

Table 9. Effect of winter cover crops and herbicide treatments on seed cotton yield from plots used to grow cotton with the production operations presented in Table 1, MAFES Delta Branch, 1982.

	Herbicide Treatment				
Cover Crop	1. Bed only	2. Roundup Bed - Cotoran	3. Roundup Bed - Treflan - Cotoran	4. Bed - Cotoran	5. Bed - Treflan - Cotoran
	(lbs/A)				
A. Wheat	200 a B	1589 a A	1625 a A	1707 a A	2034 a A
B. Vetch	233 a C	866 b B	1482 a A	719 b B	1148 b AB
C. Winter Weeds	224 a B	1597 a A	1863 a A	1740 a A	1867 a A

[1]Means within columns followed by the same lower case letter or within rows followed by the same capital letter are not different (P=0.05) according to DMRT.

Table 10. Effect of winter cover crops and herbicide treatments on the yield of seed cotton from plots used to grow cotton with the production operations presented in Table 1, MAFES Delta Branch, 1978-82 Average.

Cover Crop	Herbicide Treatment 1. Bed only	2. Roundup Bed - Cotoran	3. Roundup Bed - Treflan - Cotoran	4. Bed - Cotoran	5. Bed - Treflan - Cotoran
	(lbs/A)				
A. Wheat	984 b B	1724 a A	1762 a A	1697 a A	1824 a A
B. Vetch	1089 b C	1474 b B	1822 a A	1446 b B	1600 b B
C. Winter Weeds	1295 a B	1873 a A	1862 a A	1838 a A	1928 a A

[1]Means within columns followed by the same lower case letter or within rows followed by the same capital letter are not different (P=0.05) according to DMRT.

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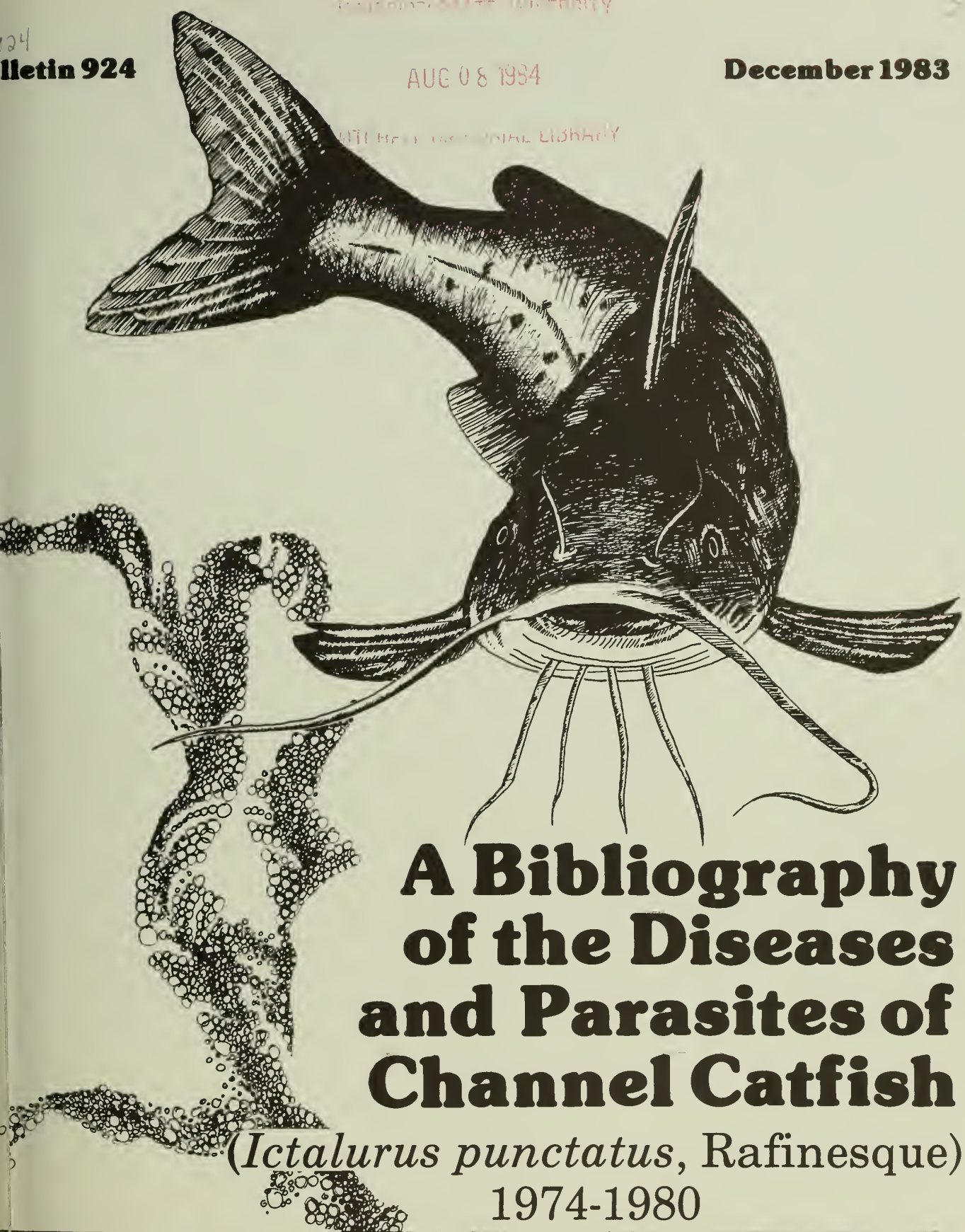

A Bibliography of the Diseases and Parasites of Channel Catfish

(*Ictalurus punctatus*, Rafinesque) 1974-1980

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A Bibliography of the Diseases and Parasites of the Channel Catfish (*Ictalurus punctatus*, Rafinesque) 1974-1980

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A Bibliography of the Diseases and Parasites of the Channel Catfish (*Ictalurus punctatus*, Rafinesque) 1974-1980

The channel catfish (*Ictalurus punctatus*, Rafinesque) has become a major cultured aquatic species in the United States. The recent growth in the commercial catfish industry has been characterized by a rapid increase in pond acreage as well as intensity of culture within the ponds. Concurrent with the growth in the importance as a cultured species, the body of knowledge describing various aspects of the health of this species has grown. Much research, both applied and basic, has been completed. This research was first brought together in a bibliography by McCraren, Wright and Jones in 1974. They cited more than 200 publications.

Since that time, the body of knowledge on channel catfish health has continued to grow. This paper is an attempt to bring together, in the form of a bibliography, those publications that have appeared in 1975 through 1980. A few references that were not included in the 1974 bibliography are included in this updated bibliography.

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A Study of Slow Rusting of Southern Rust of Corn:

Preliminary Report

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A Study of Slow Rusting of Southern Rust of Corn: Preliminary Report

Southern rust (*Puccinia polysora*) of corn is potentially devastating because commercially available hybrids are not resistant. More understanding of the nature of resistance and the multiplication and dissemination of the causal agent is needed.

The rate of multiplication and spread of the corn-rust pathogen within a growing season or from one growing season to the next varies greatly. Resistance affects the multiplication of the pathogen, not its spread. The corn-rust fungus has several reproductive cycles each growing season. The development of an epidemic is influenced by the amount of disease present at the start of the epidemic, Xo, and by its multiplication rate, described by the apparent infection rate r (13). Resistance may reduce Xo and/or r and thereby reduce field severity.

Slow rusting is a kind of resistance that should reduce the severity of the disease by decreasing the reproduction rate of the pathogen. The major components of resistance that might contribute to slow rusting usually include the following items:

Latent period (LP) is defined as the time from infection to spore production. Some examples of cultivar differences in LP have been shown in the wheat "*Puccinia recondita* f. sp. *tritici*" (9), rye "*Puccinia recondita* f. sp. *recondita*" (11), and barley "*P. hordei*" (1, 10) relationships.

Infection frequency (IF) usually is measured as pustule numbers per unit of leaf area. A good example has been reported by Clifford (4). He studied the leaf rust of barley and indicated that significantly fewer (22%) pustules developed on a resistant cultivar than on a susceptible cultivar. Furthermore, differences in IF or lesion numbers have been reported for most of the host-pathogen systems studied (1,3,4,8,9).

Effect of spore production (SP) on disease spread has been dealt with comprehensively (5,7). However, measuring spore production accurately is extremely difficult because leaf agitation before or during collection may reduce the quantity of spores collected. Thus, most studies of SP have been carried out on seedlings.

In addition, infection type reflects the nature of resistance, and this has been studied by many authors (1,2,14).

The objective of this research was to study the components of slow rusting, both on seedlings (greenhouse) and adult plants (field) of corn hybrids.

MATERIALS AND METHODS

Two greenhouse tests were carried out. In the first test, seven hybrids were used. Based on previous data, we chose Ab24E x B37R as a resistant check because we knew its level of resistance was high enough to prevent development of pustules. Other hybrids were GT112 x Tx601, Mp305 x Mp496, Mp704 x Tx 601, Mp496 x Mp702, B37 x Va35 and Mp305 x Mp339.

Each hybrid was planted at three kernels/pot in each of twelve 4-in pots on February 26, 1982. Seedlings were thinned to one per pot after emergence. There were three replications and four pots for each replication.

Plants were inoculated on March 15 while in the four- to five-leaf stage. Germinability of uredospores on water agar immediately before inoculation was 50%. Uredospores were suspended in water amended with Tween 20®. The seeding pots were arranged randomly in a dew chamber and were spray-inoculated as uniformly as possible with a hand sprayer. After 16 hrs incubation in the dew chamber, pots were moved to a greenhouse bench.

Eight days after inoculation (i.e. March 23) symptoms were visible on all hybrids. Plants were evaulated for infection type using the nine grades as follow:

1 = No symptoms
2 = Flecking indistinct
3 = Flecking distinct
4 = Necrotic or chlorotic spots, but no pustules
5 = Necrotic or chlorotic spots, with a few small unruptured pustules
6 = Numerous small pustules, with only a few ruptured
7 = Small pustules, most of which had ruptured
8 = Moderate-sized pustules and almost all ruptured
9 = Large-sized pustules and almost all ruptured

Additional evaluations were made on March 24, 26 and 29.

In the second greenhouse test, Ab24E x B37R again was used as the resistant check. In addition, two single crosses, Ab24E x SC376 and B37 x GT106, were selected as a susceptible check. Other hybrids tested were Mp496 x Mp702, Mp704

x Tx601, B37 x Va35, Mp305 x Mp496, Va35 x Mp78:518, Mp410 x SC212M and Mp490 x Tx601. Five were repeated from the first test.

The hybrids were planted on April 30 in the greenhouse. Each hybrid was planted at three kernels/pot in each of eight 4-in pots. Seedings were thinned to one seedling per pot after emergence. The six pots with the best plants were used and divided into three replications with two seedlings (pots) in each replication. Inoculation was carried out on May 18 when the seedlings were at the four- to five-leaf stage. The germinability of spores tested before inoculation was 45%. After 15 hr of incubation (i.e., on May 19, 9:30 a.m.) the pots were moved to the laboratory to avoid the high temperature of the greenhouse. Plants were grown under artificial light using a 14 hr day/10 hr night regime. Eight days after inoculation plants were evaluated for infection type using the 1-9 rating scale previously given. Additional evaluations were made at 10, 13 and 17 days after inoculation. All the other operations were the same as in the first greenhouse test.

Within five days after the appearance of symptoms, most pustules had ruptured. Spores were collected from a previously marked area on leaves 13 days after inoculation, using a mini-cyclone spore collector, and were weighed. The marked areas of leaves then were excised and measured by an automatic leaf-area meter. Finally, a count was made of pustules---both ruptured and unruptured---within the marked area.

Using seed of the same hybrids grown in the second greenhouse test, a field experiment was planted on June 7. The experiment was located on the Plant Science Research Farm at Mississippi State University. Single-row, 20-plant plots, 5 m long with 1 m between rows, were planted, with a single row of a susceptible hybrid grown in alternate rows to serve as spreader rows. The test was replicated three times. On the evening of July 23 (before tasseling) 2 ml of a spore suspension were injected into the whorl of each plant in the spreader rows. The purpose was to inoculate plants in the spreader rows from which inoculum would disseminate to test rows.

Twenty-five days after inocul tion (approximately two disea cycles) on August 17, notes on ru severity were taken. An 11-point to 10) severity scale based on pe centage of leaf area covered l pustules (0, 0.1%, 0.5%, 1%, 2.5%, 5 10%, 15%, 20%, 25%, 30% or mor was used. Leaves with a 10 ratir were considered 100% infecte because there was little or no furth increase of uredinia on them befo they became completely desiccate This visual scale was an interpol tion of a key produced by James f rating leaf rust of cereals based c percentage of leaf area covered l uredinia (6).

Visual severity ratings were tak at two positions on the plants---(the ear leaf and two leaves abo the ear leaf and (2) the top thr leaves. Ratings for the two le positions were averaged. Severi was estimated independently l two people, and the average w determined. Additional recordin were made on August 20 and 27 a on September 3.

RESULTS

Greenhouse Studies

The latent period has been defined as the time from infection to spore production (13). We feel that a practical definition of latent period for southern rust would be the time from inoculation to pustule rupture. Even though a few pustules ruptured with a rating of 6 on the rating scale we used, we feel that, when plants rate 6-7 or 7, the latent period has ended. In our tests, the latent period for most hybrids was 10 days (Table 1). Two exceptions were 9 days for GT112 x Tx601 in the first test and 13 days for Va35 x Mp78:518 in the second test. The only disagreement between the tests was with the hybrid Mp305 x Mp496, and the reason for this inconsistency is not readily apparent.

Only limited differences were noted for maximum disease ratings among the hybrids tested. In the first test, B37 x Va35 rated one grade higher than the other hybrids, and, in the second test, the two susceptible checks had the largest pustules (Table 1).

Other resistance components, such as infection frequency (pustule number) and the amount of spores produced, were significantly different among hybrids (Table 2). One of the susceptible checks, B37 x GT106, had the highest spore production and ranked third for pustule numbers, but the other susceptible check Ab24E x SC376 was less susceptible. Data on t resistant check, Ab24E x B37 were not used in the analysis b are presented for comparison wi the other hybrids in the test. Ev if Mp305 x Mp496 is not consider three-fold differences in numbers spores produced were noted amo hybrids (Table 2). Mp410 x SC21 had more than twice the number pustules found on Mp496 x Mp7

Field Test

Data obtained in the field indic ed that the two hybrids selected susceptible checks were inde susceptible and that another hybr

Table 1. Infection type and latent period of southern rust on seedlings of corn hybrids grown in the greenhouse, by pedigree of hybrids.

Pedigree	First Test: Days after inoculation 8	9	10	14	L.P. (days)	Second Test: Days after inoculation 8	10	13	17	L.P. (days)
Ab24E x B37R (Res. ck)	2	2	3	3	-	1	1	2	2	-
Mp496 x Mp702	6	6	7	7-8	10	5	6-7	7	7	10
Mp704 x Tx601	6	6	7	7-8	10	5	6-7	7	7	10
B37 x Va35	6	6	7	8-9	10	6	6-7	7	7	10
Mp305 x Mp496	6	6	7	7-8	10	4	4-5	5-6	6	-
Va35 x Mp78:518	-	-	-	-	-	5	5-6	6-7	7	13
Mp410 x SC212M	-	-	-	-	-	6	6-7	7	7	10
Mp490 x Tx601	-	-	-	-	-	6	6-7	7	7	10
Ab24E x SC376 (Susc. ck)	-	-	-	-	-	6	6-7	7-8	8	10
B37 x GT106 (Susc. ck)	-	-	-	-	-	6	7	7-8	8	10
Mp305 x Mp339	6	6	7	7-8	10	-	-	-	-	-
GT112 x Tx601	6	7	7-8	7-8	9	-	-	-	-	-

Table 2. Pustule numbers and spore amounts of southern rust on seedlings of hybrid corn grown in the greenhouse, by pedigree of hybrids.

Pedigree	Spore Amounts[x] (mg/cm^2)	Pustule Numbers (Per cm^2)
B37 x GT106 (Susceptible ck)	0.68 a	38.92 bc
Mp410 x SC212M	0.55 ab	53.76 a
Ab24E x SC276 (Susceptible ck)	0.44 abc	27.97 cd
B37 x Va35	0.43 abc	44.73 b
Mp490 x Tx601	0.30 bc	30.92 cd
Mp704 x Tx601	0.22 c	33.90 cd
Va35 x Mp78:518	0.21 c	30.90 cd
Mp496 x Mp702	0.21 c	23.29 d
Mp305 x Mp496	0.004 d	13.78 e[y]
Ab24E x B37R (Resistant ck)	None	None[z]

[x]:Means not followed by the same letter differ significantly (5% level) from each other according to Student-Newman-Keul's Test.
[y]:Some of the numbers are flecks.
[z]:There are some flecks; the density is $0.94/cm^2$.

B37 x Va35, was equally susceptible (Table 3). The other hybrids all had some characteristics of slow rusting. The differences appeared to be primarily in pustule numbers (coverage of leaf) because differences of one grade or less were observed for pustule size (infection type). The differences in disease severity were striking.

The degree of correlation between components of slow rusting is given in Table 4. Both infection type pustule numbers were highly related with spore production in greenhouse test. Spore produc in the greenhouse was correl with disease severity in the fie

Table 3. Response to infection with Puccinia polysora of corn hybrids in field tests, by pedigree of hybrids.

Pedigree	Severity of the End of Epidemic (%)[x]	Field Infection Type
B37 x GT106 (Susceptible ck)	30.00 a	8
Ab24E x SC376 (Susceptible ck)	28.33 a	7-8
B37 x Va35	28.33 a	7-8
Va35 x Mp78:518	10.83 b	8
Mp305 x Mp496	9.43 bc	7
Mp410 x SC212M	8.20 b-d	7
Mp496 x Mp702	6.83 c-e	7-8
Mp490 x Tx601	5.30 de	7
Mp704 x Tx601	3.50 e	7-8
Ab24E x B37R (Resistant ck)	0.00[y]	2-3

[x]:Means not followed by the same letter differ significantly (5% level) from each other according to Student-Newman-Keul's Test.
[y]:Hybrid Ab24E x B37R was not used in analysis of variance because it did not develop pustules.

Table 4. Correlation coefficients of resistant components of slow rusting of corn hybrids grown in the field.

	Spore Amount (SA)	Pustule Number (PN)	Severity of the end of Epidemic (SE)
Infection type (IT)	0.7762**	0.4873	0.5819[x]
Spore Amount	--------	0.7753**	0.6479*
Pustule Number	--------	--------	0.2350

**:Significant at 1% level (1% significant level = 0.765).
*:Significant at 5% level (5% significant level = 0.632).
[x]:This is the correlation coefficient between the field severity and field infection type.

DISCUSSION

The resistant components of slow rusting generally consist of longer latent period, fewer spores produced per unit leaf area, lower infection frequency in terms of pustule number and lower infection type. In the greenhouse test, one hybrid had a longer latent period than did the other hybrids. Some studies indicate that genotypes differ for latent period, and other studies do not. For instance, barley cultivars tested by Clifford (1) and Parlevliet (10) differed in latent period for barley leaf rust. A similar pattern was observed in rye for *P. recondia* f. sp. *recondita* (11). But, a test carried out on oats with *Puccinia graminis* f. sp. *avenae* showed that the host genotypes did not differ in latent period (15). Therefore, the differences in latent period among cultivars apparently vary with different crops and different diseases. In some crops, the latent period is an important component of resistance.

There was a highly significant correlation ($P = 0.01$) between infection type and spore production and between pustule numbers and spore production (Table 4). It appears that these three major components of slow rusting (resistance) are closely associated. Different components of resistance, lower infection type, reduced spore production and lower infection frequency are correlated. The variation in spore production was always closely associated with infection type. (Infection type classification is based on size of pustules.) This conclusion had been drawn by Dehne (2) who made a comprehensive study of the yellow rust disease of wheat caused by *Puccinia striiformis* and is also shown clearly in the barley leaf-rust relationship (8, 10, 12).

The susceptible checks, B37 x GT105 and Ab24E x SC376, were the most susceptible hybrids in both adult and seedling tests. In the field Mp410 x SC212M did not show as much susceptible reaction as in the greenhouse. Compared with others, B37 x Va35 was the most susceptible hybrid in both seedling and adult stages. Several other hybrids showed somewhat less disease than the susceptible check; however, this difference was not always significant in the greenhouse tests.

The disease on the susceptible hybrid in spreader rows was uniform and severe. This shows that the inoculation method of injecting spore suspension into the whorl was successful. However, the inoculating rows did not play an important role in the field test because there was an abundance of natural inoculum in 1982.

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HYBRID CORN PERFORMANCE TRIALS IN 1983

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HYBRID CORN PERFORMANCE TRIALS IN 1983

Trials are conducted annually in Mississippi to provide farmers, seedsmen, county agents and others with information on the performance of commercially available corn hybrids. Results of the trials are provided for use by corn producers in selecting hybrids suited to their area. New hybrids may be compared with familiar hybrids.

Corn hybrids respond differently to variations in environment, and a given hybrid is not always the best under all conditions. Therefore, it is suggested that corn producers grow two or more good hybrids each year. This practice also reduces the chances for spread of a disease or insect infestation through the total corn acreage.

The yield of harvestable, good-quality grain (or silage) determines the desirability of corn hybrids. However, attributes other than yield may be extremely important in some instances. For example, resistance to a particular disease should be the prime consideration in areas where the disease occurs. That is, hybrids selected should be from those known to have resistance to diseases found in a geographic area.

All producers and/or distributors of seed corn are eligible to enter hybrids in these tests. Hybrids can be entered for testing in Area 1 (northern Mississippi), Area 2, (southern Mississippi) or both. The producers designate the hybrids they want entered in each area. Hybrids must be submitted for entry to the Mississippi Agricultural and Forestry Experiment Station by February 15. A nominal fee is charged for each hybrid tested in each area to help defray costs of the tests.

Three or more tests were located in each area. Trials were conducted at nine locations in 1982 (Table 1).

The best guide to the desirability of a hybrid is its performance over a period of years at a number of locations. Therefore, three-year summaries are reported for each area.

Materials and Methods

Hybrids were tested at two population levels. The design was a randomized complete block with three replications. All tests were overplanted and later thinned to 16,000 or 22,000 plants per acre, stand permitting. Each plot consisted of two rows, 38 inches apart and 200 inches long. Fertilizer was applied by each cooperator as he thought necessary, and weeds were controlled by cultivation and herbicides.

All tests were harvested with a mechanical picker-sheller. Grain harvested from each plot was weighed, and moisture content was determined. All weights were converted to bushels per acre at 15.5% moisture.

Three or more tests were located in each area. Trials were conducted at nine locations in 1983 (Table 1).

Table 1. Location, number of entries, and dates of planting harvest of hybrid corn performance trials in Mississippi, 1983.

Area and County	Location	No. of entries	Planting date	Harvest date
Area 1				
Marshall	Holly Springs	41	April 27	Sept. 29
Pontotoc	Pontotoc	41	March 29	Sept. 23
Lee	Verona	41	April 27	--------
Washington	Stoneville	41	April 1	Sept. 27
Noxubee	Brooksville	41	May 6	Oct. 6
Oktibbeha	Mississippi State	41	April 13	Oct. 3
Area 2				
Newton	Newton	32	May 4	Sept. 15
Hinds	Raymond	32	April 20	Sept. 14
Pearl River	Poplarville	32	March 9	--------

Results and Discussion

Area 1.

Rainfall amounts were fair to good early in the season, but very limited thereafter.For reasons beyond our control, the test at Verona was abandoned. Stands were not adequate for the high population level at Brooksville; therefore, all six replications were thinned to the low plant population level. Because of field variation, differences among hybrids could not be detected at the low plant population level at Holly Springs and at the high plant population level at Mississippi State University. Therefore, the results are summarized over four and three locations for the low (Table 2) and high (Table 3) plant population levels.

Average yields of 49, 113, 88 and 121 bu/A were obtained at the low plant population level at Pontotoc, Mississippi State, Brooksville and Stoneville, respectively. Over all locations, yields ranged from 80 to 108 bu/A (Table 2) with a mean of 93 bu/A. Among hybrids tested, root lodging ranged from 1 to 17%, and stalk lodging ranged from 4 to 27%.

Average yields for all hybrids grown at 22,000 plants per acre were 43, 51 and 134 bu/A at Holly Springs, Pontotoc and Stonevi respectively. Averaged over three locations, yields and st lodging were 76 bu/A and 2 respectively (Table 3).

Average yields of the 14 hybr tested at 16,000 plants per acre at least three years ranged from to 109 with a mean of 103 bu (Table 4). Yields of these sa hybrids grown at 22,000 plants acre (not always at the same lo tions) ranged from 98.0 to 114 w a mean of 105 bu/A (Table 5).

Table 2. Summary of performance of 41 hybrids grown at four locations (Pontotoc, Mississippi State, Brooksville, and Stoneville) at 16,000 plants per acre in 1983 Mississippi hybrid corn performance trials.

Hybrid No.	Brand	Yield	Lodging root	Lodging stalk	Ear height	Days to mid silk*	Moisture	Stand
		bu/A	%	%	cm	No.	%	%
DK-747	DeKalb-Pfizer	108.0	6	11	112	79	13.3	99
3165	Pioneer	106.9	4	8	109	83	13.9	102
JX247	Jacques	103.7	8	11	108	79	12.8	104
8990	Paymaster	103.7	16	5	112	79	12.5	101
21	Coker	102.5	2	11	105	80	13.0	97
RA1604	Ring Around	101.5	9	9	103	80	12.7	101
3187	Pioneer	101.2	6	7	107	76	12.9	102
3147	Pioneer	99.0	10	17	115	83	13.0	103
DK-789	DeKalb-Pfizer	98.9	2	10	112	81	13.6	100
84aa	McCurdy	97.5	5	15	106	77	13.3	101
G-4733	Funk's	96.8	7	11	106	79	13.0	101
8400	Jacques	96.7	7	14	107	79	12.6	104
FFR-905C	Richardson	96.4	5	13	101	79	13.1	95
PX87	Northrup King	95.5	6	13	108	79	12.7	101
RA1502	Ring Around	95.3	2	8	102	75	12.6	102
3192	Pioneer	95.2	5	5	101	76	12.8	96
EXP.8006X	Funk's	95.2	14	4	114	83	13.0	100
RX909	Asgrow	93.8	8	9	98	77	13.5	102
G-4522	Funk's	93.0	4	7	101	76	12.3	98
FFR-848C	Richardson	92.7	7	9	113	78	12.3	105
3184	Pioneer	92.5	9	10	97	78	12.9	98
G-4673A	Funk's	92.3	11	10	110	78	12.5	101
EXP.7007X	Funk's	92.3	6	9	114	81	13.0	103
8150	McCurdy	91.2	11	11	115	79	13.4	101
FFR-955C	Richardson	91.0	15	11	117	82	13.4	101
PX9581	Northrup King	90.8	3	10	101	76	12.6	97
G-4740A	Funk's	89.7	6	12	96	82	12.9	95
RX114	Asgrow	89.7	9	14	110	80	12.9	98
7900	Jacques	89.0	6	10	109	76	12.8	103
G-4734	Funk's	88.3	7	11	113	80	13.6	104
508	Northrup King	87.6	3	14	135	89	14.3	98
FFR-929W	Richardson	87.5	6	13	123	81	13.7	101
XL-394	DeKalb-Pfizer	87.0	7	9	123	84	13.4	103
16	Coker	86.8	1	8	93	74	13.3	97
3369A	Pioneer	86.7	5	14	97	73	12.5	99
FFR-811C	Richardson	86.5	4	4	92	76	13.1	97
PX95	Northrup King	84.7	5	27	121	79	13.0	101
PX9692	Northrup King	83.1	7	19	109	82	13.8	95
XL-71	DeKalb-Pfizer	82.7	2	12	101	77	12.6	103
FFR-726C	Richardson	80.8	6	9	98	75	12.3	99
519	Pioneer	80.3	17	12	118	82	13.1	102
Mean		93.0	7	11	108	79	13.0	100

CV = 14.22%

LSD (.05) = 9.61 bu/A

*Data for Mississippi State only.

rea 2.

Early flooding of the test at oplarville caused poor stands in ections of most replications. herefore, we abandoned this test.

At population levels of 16,000 lants per acre, yields ranged from 3 to 106 and 47 to 103 bu/A at lewton and Raymond, respectively. veraged over the two locations, yields ranged from 56 to 93 with a mean of 79 bu/A (Table 6). Root and stalk lodging were of minor consequence.

At population levels of 22,000 plants per acre, yields ranged from 61 to 109 and 59 to 104 bu/A at Newton and Raymond, respectively. Averaged over the two locations, yields ranged from 67 to 102 with a mean of 83 bu/A (Table 7).

Yields of the 14 hybrids tested at 16,000 plants per acre for at least three years ranged from 61 to 81 with a mean of 70 bu/A (Table 8). Yields of these same hybrids grown at 22,000 plants per acre ranged from 59 to 76 with a mean of 67.0 bu/A (Table 9).

Table 3. Summary of performance of 41 hybrids grown at three locations (Holly Springs, Pontotoc, and Stoneville) at 22,000 plants per acre in 1983 Mississippi hybrid corn performance trials.

Hybrid No.	Brand	Yield	Lodging root	Lodging stalk	Ear height	Days to Mid silk*	Moisture	Stand
		bu/A	%	%	cm.	no.	%	%
8990	Paymaster	91.6	12	15	126	81	12.5	99
RX909	Asgrow	90.2	15	22	110	78	12.1	95
3165	Pioneer	87.4	8	13	126	81	13.5	99
8400	Jacques	87.1	15	22	122	79	13.1	98
PX9581	Northrup King	86.3	9	16	113	76	13.3	97
G-4522	Funk's	85.9	9	13	114	78	11.4	95
84AA	McCurdy	85.7	12	20	122	78	13.7	95
DK-789	Dekalb-Pfizer	85.1	8	16	125	79	12.4	97
3187	Pioneer	83.8	18	9	109	78	12.6	95
JX247	Jacques	82.7	13	18	117	79	12.6	100
7900	Jacques	82.2	22	20	121	76	12.4	101
RA1502	Ring Around	81.3	7	25	112	78	12.9	99
PX9692	Northrup King	80.9	13	28	121	79	12.2	91
FFR-811C	Richardson	78.8	12	12	104	77	12.4	90
3184	Pioneer	78.4	21	7	107	79	12.0	99
RA1604	Ring Around	78.1	14	18	120	79	13.0	98
G-4673A	Funk's	77.6	7	21	109	78	12.6	95
G-4740A	Funk's	77.2	13	17	105	84	13.1	91
3192	Pioneer	76.5	6	18	109	78	12.7	91
XL-394	Dekalb-Pfizer	75.2	13	19	137	84	12.9	91
FFR-726C	Richardson	75.0	15	18	105	75	12.4	93
FFR-848C	Richardson	74.9	11	26	117	78	11.9	97
XL-71	Dekalb-Pfizer	74.7	6	16	112	78	12.6	96
21	Coker	73.7	10	13	113	80	12.7	96
16	Coker	73.6	12	17	101	75	11.9	91
PX87	Northrup King	72.9	17	16	116	80	12.5	94
G-4733	Funk's	71.2	17	21	117	80	13.1	97
8150	McCurdy	69.7	11	17	132	80	13.2	93
FFR-905C	Richardson	69.6	15	29	119	80	12.8	93
3369A	Pioneer	69.1	9	30	112	76	12.4	95
EXP.8006X	Funk's	68.5	22	23	127	84	12.3	92
G-4734	Funk's	68.2	13	24	117	80	13.6	95
DK-747	DeKalb-Pfizer	67.9	12	21	130	81	12.8	94
FFR-955C	Richardson	67.6	22	16	126	82	14.2	94
EXP.7007X	Funk's	67.5	15	21	122	81	12.6	98
RX114	Asgrow	67.1	18	28	122	80	12.4	91
519	Pioneer	66.5	21	24	137	82	12.4	97
PX95	Northrup King	64.0	12	31	135	79	12.3	97
FFR-929W	Richardson	62.4	16	25	132	83	12.7	89
508	Northrup King	62.1	5	28	140	90	14.2	81
3147	Pioneer	62.1	18	20	124	82	13.1	94
MEAN		75.6	13	20	119	80	12.7	95

CV = 18.46%

LSD (.05) = 13.10 bu/A

*Data for Mississippi State only.

Table 4. Three-year (1981-83) average performance of 14 hybrids grown in Area I at 16,000 plants per acre in the Mississippi hybrid corn performance trials.

Hybrid No.	Brand	Yield	Lodging		Ear heights	Days to mid silk	Mois-ture	Stan
			root	stalk				
		bu/A	%	%	cm.	no.	%	%
3147	Pioneer	108.9	4	13	118	84	14.2	98
21	Coker	107.5	1	13	110	81	13.7	98
G-4733	Funk's	107.2	2	6	110	80	14.1	100
84aa	McCurdy	105.9	2	12	106	78	13.7	97
8150	McCurdy	105.9	5	7	117	80	14.0	101
PX87	Northrup King	105.0	2	12	112	80	13.5	101
508	Northrup King	104.3	2	13	134	90	15.2	101
XL-394	Dekalb-Pfizer	103.4	4	9	125	85	14.4	104
RA1604	Ring Around	102.9	3	13	111	80	13.6	98
PX95	Northrup King	100.3	4	16	122	81	13.9	100
3369A	Pioneer	99.6	2	12	101	75	13.2	96
G-4522	Funk's	99.6	2	9	101	76	13.1	96
519	Pioneer	97.3	7	10	124	83	13.7	101
XL-71	DeKalb-Pfizer	95.6	1	8	104	78	13.2	101
MEAN		103.1	3	11	114	81	13.8	99

Table 5. Three-year (1981-83) average performance of 14 hybrids grown in Area I at 22,000 plants per acre in the Mississippi hybrid corn performance trials.

Hybrid No.	Brand	Yield	Lodging		Ear heights	Days to mid silk	Mois-ture	Stand
			root	stalk				
		bu/A	%	%	cm	no.	%	%
84aa	McCurdy	114.1	4	15	116	79	14.0	96
21	Coker	113.5	4	12	115	81	13.4	97
RA1604	Ring Around	107.9	5	14	118	80	13.9	96
PX 87	Northrup King	107.9	6	14	118	81	13.6	94
8150	McCurdy	106.8	4	13	124	81	14.5	95
G-4522	Funk's	106.7	3	9	107	78	12.6	94
3147	Pioneer	105.8	7	13	124	83	14.6	93
G-4733	Funk's	103.2	6	12	112	81	14.4	97
XL-71	DeKalb-Pfizer	101.9	2	14	109	79	13.7	95
XL-394	DeKalb-Pfizer	101.9	6	13	132	85	14.1	93
508	Northrup King	101.0	2	18	137	91	15.2	91
PX95	Northrup King	99.4	6	18	130	81	13.5	96
519	Pioneer	97.9	9	14	133	83	13.5	95
3369A	Pioneer	98.0	3	20	110	77	13.6	94
MEAN		104.7	5	14	120	81	13.9	94

Table 6. Summary of performance of 32 hybrids grown at two locations (Newton and Raymond) at 16,000 plants per acre in 1983 Mississippi hybrid corn performance trials.

Hybrid No.	Brand	Yield	Lodging root	Lodging stalk	Ear heights	Moisture	Stand
		bu/A	%	%	cm	%	%
DK-747	DeKalb-Pfizer	93.3	0	0	107	15.2	99
77B	Coker	91.3	0	4	130	17.6	100
3147	Pioneer	91.2	0	4	111	15.5	100
3055	Pioneer	91.1	0	4	114	16.5	101
XL-394	DeKalb-Pfizer	87.8	1	3	123	17.2	98
3187	Pioneer	87.5	0	1	109	14.0	100
8172	McCurdy	85.7	0	4	104	15.7	98
12052A	Paymaster	85.5	0	1	108	18.7	100
8951	Paymaster	84.8	0	0	103	15.2	100
8990	Paymaster	83.3	0	2	99	13.4	99
519	Pioneer	82.7	0	1	115	15.3	100
3165	Pioneer	82.3	0	5	103	14.3	98
EXP.8003X	Funk's	81.4	0	3	106	16.0	100
EXP.8006X	Funk's	81.2	0	3	108	16.0	99
3320	Pioneer	80.7	0	3	94	14.3	100
81-37	McCurdy	80.0	0	5	105	15.9	100
G-4734	Funk's	79.2	0	2	102	15.3	99
G-4522	Funk's	79.2	0	4	91	14.4	94
DK-789	DeKalb-Pfizer	79.1	0	7	95	15.0	99
8400	Jacques	78.4	0	2	96	15.0	98
3369A	Pioneer	78.1	0	5	92	14.1	99
RA1502	Ring Around	77.9	0	3	96	14.6	97
PX9692	Northrup King	77.7	0	4	107	16.2	100
JX247	Jacques	77.2	0	4	95	14.8	99
PX9581	Northrup King	74.8	0	4	93	13.8	99
RA1604	Ring Around	72.3	0	3	94	17.9	98
22	Coker	71.6	0	3	97	14.8	97
508	Northrup King	71.2	0	8	128	17.9	99
G-4733	Funk's	71.1	0	3	96	15.8	98
7900	Jacques	65.3	0	3	96	14.7	98
G-4740A	Funk's	62.1	0	9	82	15.2	95
XL-71	DeKalb-Pfizer	55.9	0	2	88	14.6	98
MEAN		79.4	0	3	103	15.5	99

CV = 18.24%

LSD (.05) = 16.72 bu/A

Table 7. Summary of performance of 32 hybrids grown at two locations (Newton and Raymond) at 22,000 plants per acre in 1983 Mississippi Hybrid Corn Performance Trials.

Hybrid	Brand	Yield	Lodging root	Lodging stalk	Ear height	Moisture	Stand
		bu/A	%	%	cm	%	%
8400	Jacques	101.9	0	2	107	14.1	100
3055	Pioneer	100.3	0	3	118	14.8	97
EXP.8003X	Funk's	97.1	0	1	110	16.3	100
12052A	Paymaster	93.4	0	2	114	16.8	95
81-37	McCurdy	92.4	0	3	116	14.5	97
3187	Pioneer	91.3	0	2	110	13.3	96
519	Pioneer	89.6	1	1	121	14.8	98
RA1604	Ring Around	89.3	1	2	106	13.8	99
8172	McCurdy	89.2	0	2	121	15.7	100
3165	Pioneer	88.3	0	4	110	14.9	94
G-4733	Funk's	87.4	0	0	100	17.0	95
DK-747	DeKalb-Pfizer	87.0	0	4	110	15.7	97
EXP.8006X	Funk's	86.5	1	5	109	14.0	96
XL-394	DeKalb-Pfizer	86.4	0	6	119	16.3	96
508	Northrup King	86.3	0	2	133	16.7	96
8951	Paymaster	85.9	0	5	102	13.4	94
8990	Paymaster	82.4	0	1	103	15.2	97
PX9692	Northrup King	82.4	0	4	113	14.0	94
G-4740A	Funk's	82.2	0	5	95	16.1	96
3147	Pioneer	78.0	0	4	115	15.6	96
PX9581	Northrup King	77.7	0	2	94	13.6	96
3369A	Pioneer	77.6	0	2	95	13.4	95
7900	Jacques	77.5	0	1	100	12.9	97
DK-789	Dekalb-Pfizer	76.7	0	7	107	15.2	94
77B	Coker	76.2	0	7	129	18.3	94
JX247	Jacques	76.2	0	3	104	15.4	96
RA1502	Ring Around	76.2	0	2	95	14.5	91
G-4734	Funk's	73.6	0	4	98	15.0	97
3320	Pioneer	71.4	0	4	94	14.0	95
G-4522	Funk's	71.1	2	5	92	14.8	93
22	Coker	70.9	0	5	103	14.9	97
XL-71	DeKalb-Pfizer	67.1	0	5	93	14.5	93
MEAN		83.4	0	3	107	15.0	96

CV = 18.40%

LSD (.05) = 17.72 bu/A

Table 8. Three-year (1981-83) average performance of 14 hybrids grown in Area II at 16,000 plants per acre in the Mississippi Hybrid Corn Performance Trials.

Hybrid No.	Brand	Yield	Lodging root	Lodging stalk	Ear height	Moisture	Stand
		bu/A	%	%	cm	%	%
12052A	Paymaster	80.9	1	1	98	20.0	99
3147	Pioneer	78.2	1	4	97	17.7	96
XL-394	DeKalb-Pfizer	73.5	1	2	107	17.6	96
508	Northrup King	72.8	0	6	116	19.8	98
8951	Paymaster	72.1	1	4	93	17.5	95
77B	Coker	71.8	0	5	105	20.4	93
3320	Pioneer	71.0	1	4	85	16.7	93
519	Pioneer	70.8	1	4	103	16.1	94
G-4522	Funk's	70.3	0	6	84	16.8	91
G-4733	Funk's	68.7	0	3	87	18.3	94
3369A	Pioneer	67.4	1	5	83	16.2	95
RA-1604	Ring Around	64.7	0	7	90	18.0	92
22	Coker	62.8	0	5	92	17.8	95
XL-71	DeKalb-Pfizer	61.0	0	4	85	16.4	99
MEAN		70.4	1	4	95	17.8	95

Table 9. Three-year (1981-83) average performance of 14 hybrids grown in Area II at 22,000 plants per acre in the Mississippi Hybrid Corn Performance Trials.

Hybrid No.	Brand	Yield	Lodging root	Lodging stalk	Ear height	Moisture	Stand
		bu/A	%	%	cm	%	%
G-4733	Funk's	75.9	0	3	93	18.3	91
508	Northrup King	74.0	0	6	114	20.5	83
12052A	Paymaster	72.8	3	4	99	20.5	90
519	Pioneer	71.2	1	4	106	16.2	93
8951	Paymaster	70.1	0	7	92	16.6	93
XL-394	DeKalb-Pfizer	68.7	1	5	103	18.3	88
3147	Pioneer	67.6	0	8	101	17.7	94
77B	Coker	66.9	2	7	115	19.2	90
RA1604	Ring Around	66.8	0	9	96	17.1	92
3320	Pioneer	62.4	0	6	91	16.7	89
3369A	Pioneer	62.3	1	6	86	16.1	88
XL-71	DeKalb-Pfizer	62.0	0	9	86	17.5	86
G-4522	Funk's	59.1	1	7	85	16.1	83
22	Coker	59.0	0	11	92	17.1	85
MEAN		67.0	1	7	97	17.7	90

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Mississippi State, University

PERENNIAL VINES

in the Delta of Mississippi

USDA, ARS
in cooperation with

MAFES MISSISSIPPI AGRICULTURAL & FORESTRY EXPERIMENT STATION
R. RODNEY FOIL, DIRECTOR MISSISSIPPI STATE, MS 39762

Mississippi State University
James D. McComas, President Louis N. Wise, Vice President

PERENNIAL VINES IN THE DELTA OF MISSISSIPPI

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Perennial Vines in the Delta of Mississippi

Perennial vines are common and troublesome weeds in row crops in the Mississippi Delta. They are difficult to control with herbicides now available and are increasing in economic importance throughout the Delta, especially with the emphasis on reduced tillage practices to prevent soil erosion. These weeds reduce yields, increase the difficulty of harvesting, reduce the quality of harvested produce and greatly increase the cost of production.

Producers and weed science professionals are aware of these weeds, but, due to regional differences, the same weed may have several different common names (e.g.; trumpet-creeper, buck vine and cow itch vine are the same). Some of the less common vines may not be known by name to producers (e.g.; redberry moonseed). Thus, accurate identification is important for effective communication between producers and weed science professionals. The objective of this publication is to document, by species, the prevalence of perennial vines in row crops in the Delta of Mississippi and to present a simplified, illustrated key for their accurate identification.

Procedure

The 100 sites selected for the field survey in the Delta of Mississippi were apportioned among counties according to the acreages of cotton and soybeans in each county. The sites were determined by randomly selecting a page from the aerial photographs of the county soil survey. The sites then were selected randomly from a grid placed over each selected page. Lakes, forests and other uncultivated sites were not included in the survey. Alternate sites were selected if land use had changed since the aerial photographs were taken (e.g.; rice paddy or catfish pond). The predetermined sites were surveyed in late August 1981 and late August-early September 1982. Fields were sampled by a walking survey. The data recorded for each site included crop planted, presence of perennial vines by species and an abundance rating by species according to the following scale:

0 = none present
1 = rare, 1 to a few plants seen (< 1% area coverage)
2 = infrequent, more than 1 (1-10% area coverage)
3 = occasional (10-20% area coverage)
4 = common, (20-50% area coverage)
5 = abundant (> 50% area coverage)

Two observers made independent ratings, and assigned rating was by consensus. A few sites were visited by a single observer, but only after considerable rating experience.

Results and Discussion

Redvine was found in 52% of the cotton fields and 37% of the soybean fields (Table 1), with an average infestation of 42% of the row crops. Other perennial vines and their infestation rate were trumpet-creeper, 29%; honeyvine milkweed, 12%; redberry moonseed, 8%; Illinois bundleflower, 6% and bigroot morningglory, 4%. Vines, with the exception of Illinois bundleflower, seemed to be more prevalent in cotton than in soybeans, perhaps due to the more open canopy of cotton. Illinois bundleflower was

Table 1. Frequency of occurrence and senerity of infestations of perennial vines in cotton and soybean fields in the Delta of Mississippi, by species, 1982.

Crop	No. of Fields	Perennial vine species. Redvine				Trumpet-creeper				Honeyvine milkweed				Redberry moonseed				Illinois bundleflower				Bigroot morningglory			
		Rating[a] 0	1	>1		0	1	>1		0	1	>1		0	1	>1		0	1	>1		0	1	>1	
		----%----			$\bar{x}$	-----%----			$\bar{x}$	-----%---			$\bar{x}$	----%---			$\bar{x}$	----%---			$\bar{x}$	----%---			$\bar{x}$
Cotton	35	48	9	43	1.1	71	11	17	0.5	77	17	6	0.3	83	9	9	0.3	97	3	0	>0.1	91	0	9	0.2
Soybean	65	63	6	31	0.8	71	9	20	0.6	94	3	3	0.1	97	2	2	>0.1	92	8	0	0.1	98	0	2	>0.1
Total	100	58	7	35	0.9	71	10	19	0.6	88	8	4	0.2	92	4	4	0.1	94	6	0	0.1	96	0	4	0.1

[a]Rating follows the scale given in the text.
0 = none found
1 = rate < 1% area coverage
> = greater than 1% area coverage

more abundant in the fine-textured clay soils, which are more often planted to soybeans.

The average rating followed the same pattern as their occurrence. Redvine and trumpetcreeper had the highest rating and, of the others, only honeyvine milkweed and redberry moonseed were found with enough frequency to permit a substantial rating, and then only in cotton.

In a few scattered cases, honeyvine milkweed, redberry moonseed and bigroot morningglory infestations were prevalent enough to be of concern, mostly in cotton. Illinois bundleflower rated no higher than 1. This species, however, may be on the increase with the increased emphasis on reduced tillage.

Identification of the perenn vines, especially some of the le common ones, is difficult. Most the less common ones are not list in current weed identificati guides, and the weeds are identifi improperly in some of these guid For this reason, an illustrated k is provided below.

Vegetative Key to Perennial Vines

1. Leaves simple See 2

2. Leaves opposite *Cynanchum laeve* (Michx.) Pers.

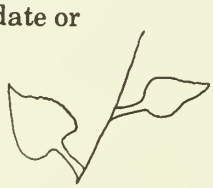
Honeyvine milkweed (Figure 1).

2. Leaves alternate See 3

3. Tendrils present *Brunnichia cirrhosa* (Gaertn.)

Redvine (Figure 2)

3. Tendrils absent See 4

4. Leaves cordate or pandurate  *Ipomoea pandurata* (L.) G. F. W. M

Big Root morningglory (Figure 3)

4. Leaves variable, entire or hastately lobed

Cocculus carolinas (L.) DC

Redberry moonseed (Figure 4)

1. Leaves compound

See 5

5. Leaves opposite, once pinnately compound

Campsis radicans (L.) Seem.

Trumpetcreeper (Figure 5)

5. Leaves twice pinnately compound

Desmanthus illinoensis (Michx.) MacM.

Illinois bundleflower (Figure 6)

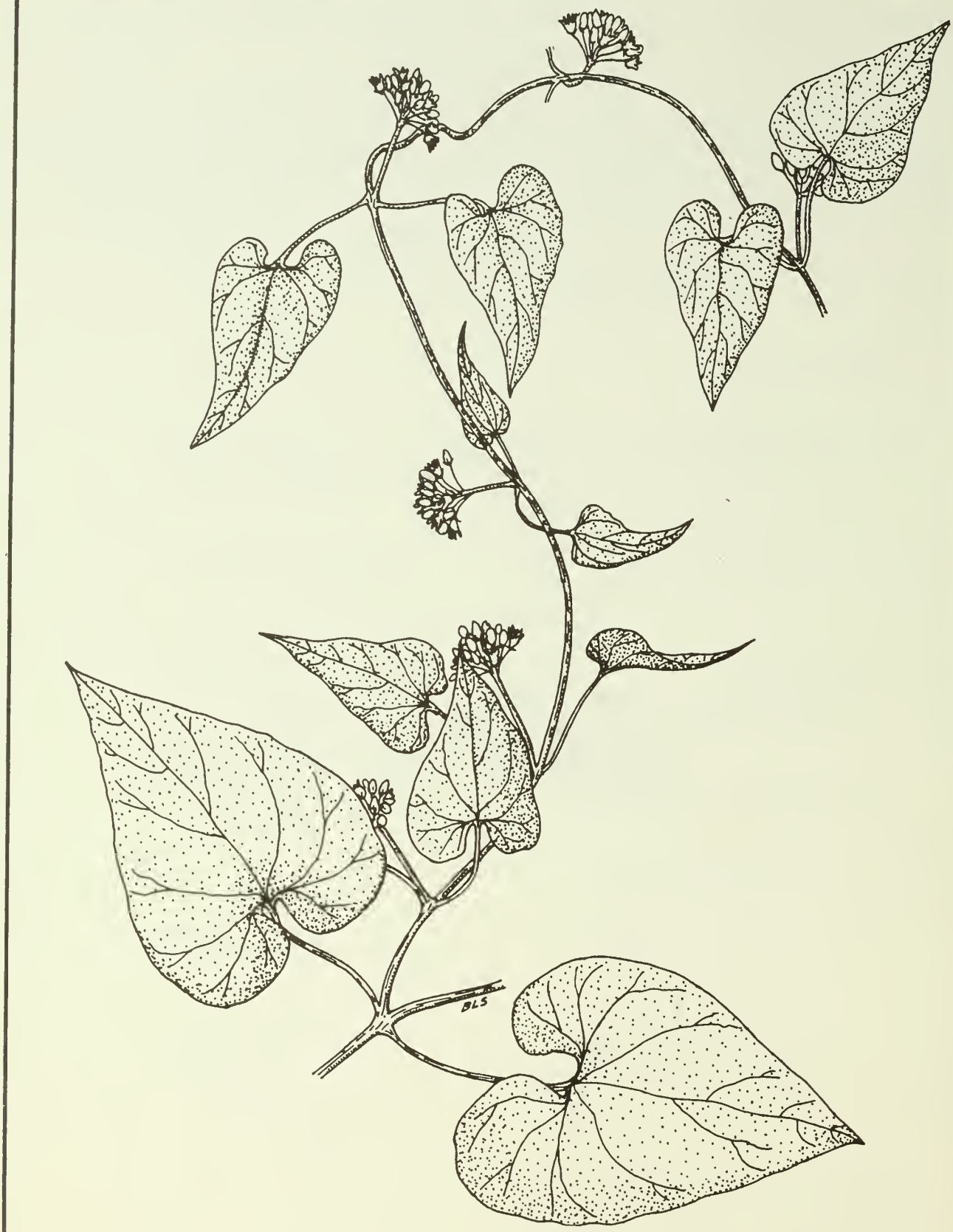


Figure 1. Honeyvine milkweed [*Cynanchum laeve* (Michx.) Pers.]

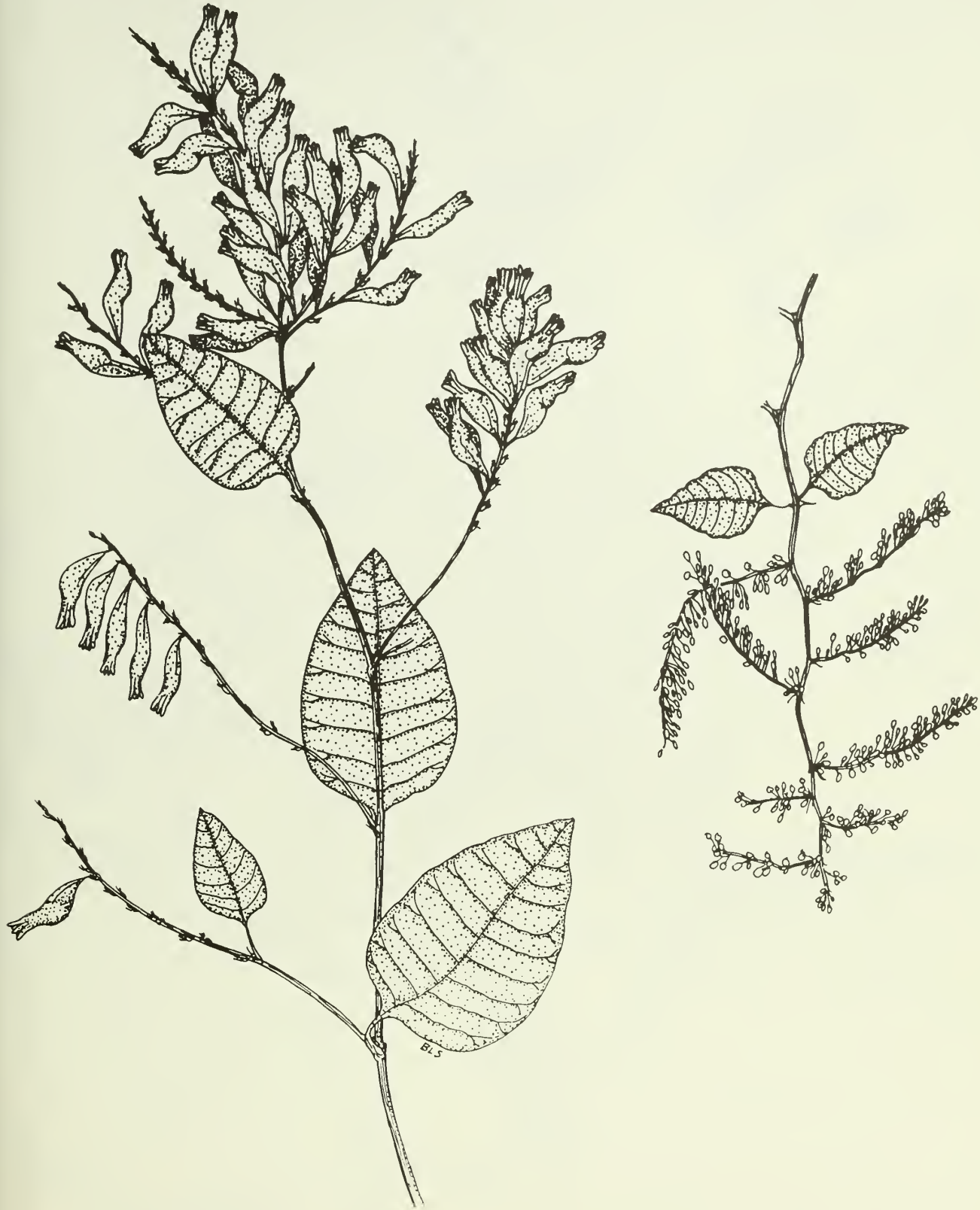


Figure 2. Redvine [*Brunnichia ovata* (Walt.)]

Figure 5. Trumpetcreeper [*Campis radicans* (L.) Seem.]

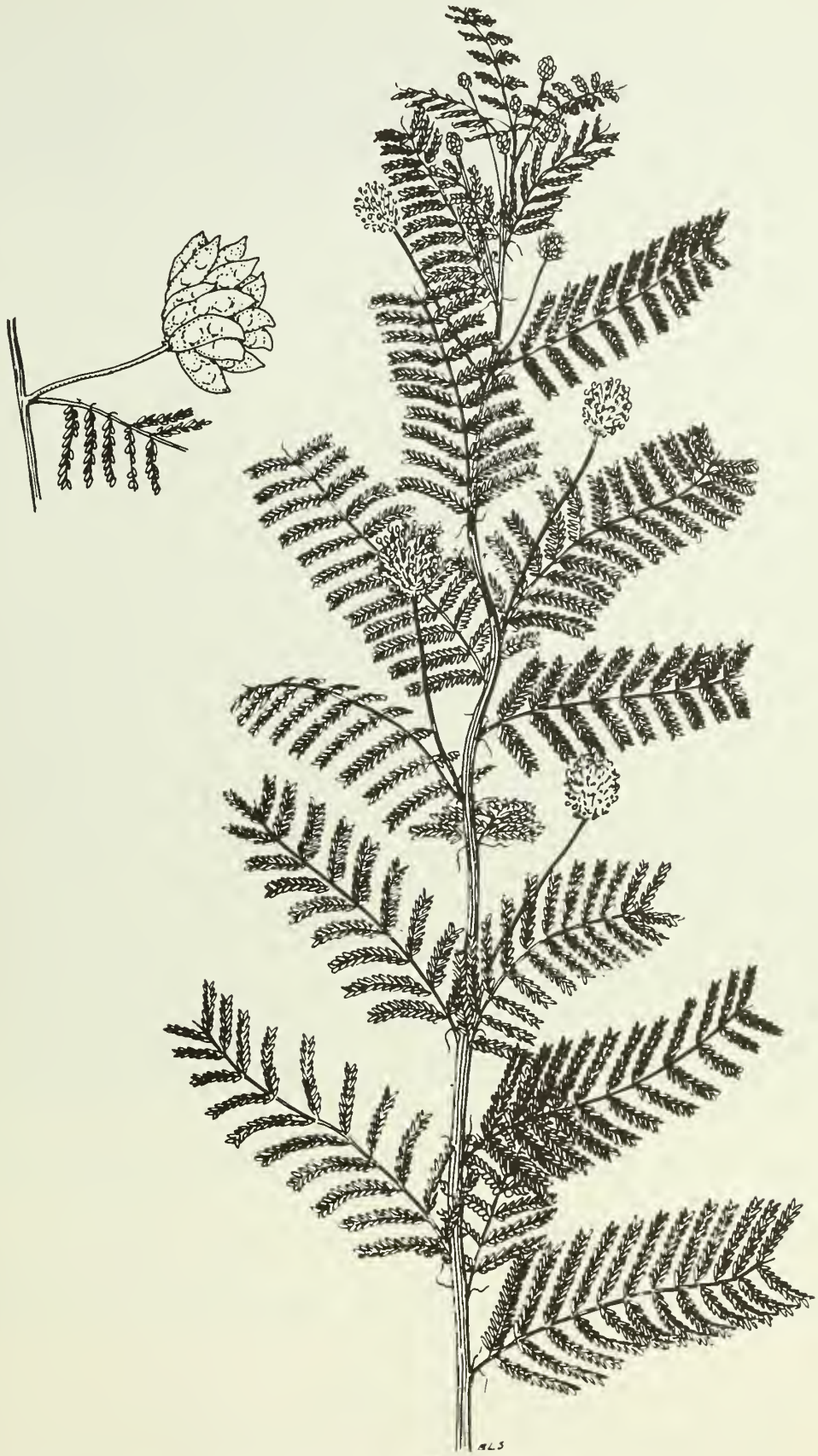


Figure 6. Illinois bundleflower [*Desmanthus illinoensis* (Michx.) MacM.]

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An Economic Analysis of Soybean Yield Response to Irrigation of Mississippi River Delta Soils

ARS, USDA
in cooperation with

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An Economic Analysis of Soybean Yield Response to Irrigation of Mississippi River Delta Soils

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An Economic Analysis of Soybean Yield Response to Irrigation of Mississippi River Delta

SUMMARY AND CONCLUSIONS

This study addressed the economic aspects of several factors that can affect the yield response of soybeans to irrigation in the Delta of Mississippi. Two irrigation systems were used in this analysis as a basis for estimating irrigation costs. These systems included a center-pivot system irrigating 130 acres on one pivot point and a gated-pipe system irrigating 160 acres. Data on the yield response of irrigated soybeans associated with alternative production patterns and irrigation applications were obtained from research conducted at the MAFES Delta Branch.

Soybeans planted in mid-May and irrigated regularly from the beginning of bloom to the end of podfill generally resulted in higher returns above estimated direct and total costs of irrigation than from soybeans planted in late May or early June and irrigated by the same guidelines. Returns above estimated direct and total costs of irrigation for common furrow-irrigation systems averaged approximately $30.00 per acre higher on soybeans planted in mid-May versus later-planted soybeans.

Irrigation of soybeans appears to be more economical if started during early reproductive stages of the plant if drought occurs at this stage. Returns above estimated direct and total costs of irrigation were generally greatest when irrigation was initiated just before or at the beginning of bloom. Returns from irrigation initiated at podset were generally positive but somewhat lower than returns from irrigation started earlier. Irrigation started at the beginning of podfill almost always resulted in very low or negative returns above irrigation costs per acre.

Both furrow and sprinkler systems were generally shown to increase yields, but the amount of water applied will determine which type of system is more economical. Fixed costs per acre were shown to be significantly higher for a center-pivot system than for a gated-pipe system. However, operating costs were higher for the furrow system than for the center-pivot system.

Irrigation of soybeans planted in narrow rows rather than wide rows on Sharkey clay soils may increase yields and returns in a very dry year. However, no consistent differences in returns to irrigation of soybeans planted in narrow versus wide rows were observed over the time period covered by this study.

Irrigating a clay soil according to the soil water potential (SWP) at the 24-inch soil depth required less water and resulted in lower costs per acre than did irrigating according to the SWP at the 12-inch depth. However, in two-thirds of the cases, returns above estimated direct and total irrigation costs were greater when irrigation applications were based on the SWP at the 12-inch depth.

Soybean yields are influenced directly by both the amount and distribution of rainfall. The crop must have adequate soil moisture throughout the growing season for proper plant growth and development. It has been estimated that 18 to 26 inches of water per acre are necessary for soybeans to reach their yield potential. During years of low rainfall, insufficient soil moisture can result in plant stress and reduction in yield unless irrigation is available for applying water to the crop when needed.

The rate of water use by soybeans averages about 0.15 inch per day over the entire growing season. Demand for water by soybeans peaks during the reproductive stage of plant development when water use may be up to 0.4 inch per day (Heatherly, et al). This high moisture requirement period for soybeans usually occurs during the months of July, August and September. In the Delta of Mississippi this time period is representative of a period of high temperatures combined with relatively low and/or poorly distributed rainfall. Adequate soil moisture during this period is critical for proper reproductive development of the soybean plant. Irrigation during this time can be beneficial in supplying sufficient moisture to the soybean plant and may serve to reduce the year-to-year variation in soybean yields

often associated with non-irrigated soybean fields.

A four-year study of soybean irrigation was completed recently at the MAFES Delta Branch (Heatherly). Factors such as planting date and row spacing, in conjunction with alternative methods and timing of irrigation, were evaluated to determine their impact on soybean yields. This report presents an economic analysis of these factors in relation to estimated costs and returns of soybean irrigation.

OBJECTIVES

The objectives of this study were:

1. To update the direct and total costs per acre of representative irrigation systems used to irrigate soybeans in the Mississippi Delta.

2. To evaluate the feasibility of alternative irrigation applications and timing on soybean production with alternative production patterns, such as planting date and row spacing.

3. To determine break-even yield requirements for selected methods and timing of irrigation.

SOURCES OF DATA

Costs of irrigation systems included in this report were obtained from a study of soybean irrigation performed by the Department of Agricultural Economics at Mississippi State University (Rebsamen). The basic investment data were obtained from well-drilling firms and irrigation-equipment dealers located in the study area in 1979 and 1980. Investment and operating costs were obtained by interviewing 52 farmers who irrigated soybeans in the Delta during 1979 and 1980. In addition, 50 farmers kept irrigation records that provided other information for the study conducted by Rebsamen.

Data on the agronomic response of soybeans to irrigation were obtained from experiments conducted at the MAFES Delta Branch (Heatherly). The data included yields of soybeans grown with similar production practices and different row spacings with and without irrigation. Soybeans were irrigated by alternative methods and at different stages of development.

METHODS OF ANALYSIS

The costs of representative irrigation systems included in this report were based on estimates obtained from Rebsamen's study and were updated for 1983. Costs were estimated for a center-pivot system irrigating 130 acres and a gated-pipe system irrigating 160 acres. Fixed and direct irrigation costs for these systems were estimated in accordance with published agricultural production cost data for the Delta of Mississippi (Cooke, et al.). All other production costs were assumed to be the same because the same production practices were followed for the irrigated and non-irrigated plots.

Calculated direct costs of irrigation were based on 1 acre-inch per application for the center-pivot system and 4 acre-inches per application for the gated-pipe system. All fixed costs were estimated on a per acre basis.

These costs were then assumed to be representative of the cost of alternative irrigation application tests performed at the MAFES Delta Branch in order to estimate the cost of applying water by different methods. Irrigation application rates were combined with estimated fixed and direct costs to estimate total irrigation costs for each test conducted. Yield of irrigated plots above yields of non-irrigated checks for each test were used as a basis for estimating returns above irrigation costs. Break-even yields also were developed for each test.

It should be noted that experimental results obtained by Heatherly were achieved utilizing a fixed-sprinkler ("rainbird") system and by furrow-or surface irrigation methods. The cost of a center-pivot irrigation system was substituted in this study for the cost of the "rainbird" fixed-sprinkler system in order to estimate the benefits of overhead irrigation of soybeans. Thus, this study assumes that results obtained from the "rainbird" fixed-sprinkler irrigation system would be representative of results obtained from a center pivot system.

DESCRIPTION OF SOILS

Most of the irrigation experiments were conducted primarily on Sharkey clay, which has about 1% organic matter, very slow internal drainage, high fertility, low bulk density, uniformity with depth and no compacted zones. This soil type shrinks and cracks when drying and swells when wet. Its relatively slow release of water to plants results in soybean vegetative growth being somewhat slower than when soybeans are grown on a silt loam or a very fine sandy loam soil.

Other tests were conducted on a Dubbs silt loam site. This soil has good internal drainage but forms a surface crust that severely inhibits water infiltration. This is an important factor to consider when watering by furrow methods because the rate of water application should not exceed the capacity of the soil to absorb it. This soil supplies water to the crop at a relatively rapid rate and this can result in the production of vegetative growth, which requires frequent application of water to maintain the plant in a nonstressed condition. Atmospheric conditions that promote transpiration from leaves can cause severe wilting of plants grown on soils of this type if water is not immediately available.

ESTIMATED COSTS OF REPRESENTATIVE IRRIGATION SYSTEMS

Center-Pivot Irrigation Systems

A quarter-mile center-pivot system irrigating 130 acres on one pivot point was considered for this analysis. Estimated fixed and direct costs of such a system are presented in Table 1. Investment costs for this system included the cost of an engine, well, pump, gearhead, generator, fuel tank and lines and the pivot system. Total investment costs for this system were $59,150. Total fixed costs consist of annual depreciation, interest on investment and insurance. Annual depreciation was calculated for each component of the system using the straight-line method with a zero salvage value. Annual interest charges were based on 14% of one half of the original investment. Insurance was estimated at 1% of the original investment. Total annual fixed costs for the system were estimated as $8,560.33 or $65.85 per acre.

Operating or direct costs of a pivot system include fuel, oil, labor and engine repair. Fuel is the major direct cost of operating a center-pivot system. Fuel requirements included in this analysis were based on an engineering formula that estimated the power requirements of pumping water from its source to the point of discharge (Johnson and Henderson).

Direct costs of operating a quarter-mile pivot system on one pivot point were estimated to be $338.10 per revolution with a 1-inch application rate. This is equivalent to $2.60 per acre-inch of water applied.

Gated-Pipe Irrigation System

The estimated fixed and direct costs of a gated-pipe system irrigating 160 acres are presented in Table 2. Investment in this system included the cost of an engine, well, pump, gearhead, fuel tank and lines and gated pipe. Total investment costs for this system were estimated to be $28,920. Annual depreciation costs were estimated using the straight-line method with a zero salvage value. Annual interest charges were estimated at 14% of one half of the original investment. Insurance was estimated at 1% of the original investment. Total annual fixed costs for the gated-pipe system were $3,910.73 or $24.44 per acre. No land-forming costs were charged to the gated-pipe system. The cost of land forming for specific situations must be included when evaluating the feasibility of using a gated-pipe system to irrigate soybeans on a field requiring land forming.

The gated-pipe system included in this study was assumed to be used to irrigate 160 acres of soybeans. Irrigation water was pumped at a flow rate of 2,000 gallons per minute and 34 PSI. Direct costs for this system included fuel, oil, labor, engine repairs and pipe replacement. Direct costs per acre for a 4-inch application of water were estimated. Diesel fuel costs for the tractor and labor costs reflect the costs of moving and setting up irrigation pipe. Total direct costs for the gated-pipe system were estimated to be $11.73 per acre or about $2.94 per acre-inch of water applied.

Although the amounts of irrigation water applied by the furrow and sprinkler systems in this study were not equal, some general conclusions can be drawn concerning the costs of different irrigation methods. The center-pivot system was estimated to have the lowest direct or operating cost of the

systems included in this analysis. The estimated direct cost for this system was $2.60 per acre-inch of water applied. This was primarily due to low labor requirements for center-pivot systems. The furrow-irrigation system required greater amounts of labor for operation, thereby resulting in higher direct costs. Estimated direct costs for the gated-pipe system included in this analysis were $2.94 per acre-inch of water applied.

Investment costs of the center-pivot system, however, were muc greater than investment costs for gated-pipe system. Fixed costs fo the center-pivot system included i this report were $64.85 per acr while fixed costs for the gated-pip system were $24.44 per acre.

ANALYSIS OF FACTORS AFFECTING IRRIGATION COSTS AND RETURNS

Estimated fixed and direct costs of the two irrigation systems presented in the previous section were used to develop estimated irrigation costs, returns and break-even yield increases. Reference is made to the year in which a particular agronomic study was conducted, but all estimated costs and break-even yield increases presented in the remainder of this report were based on 1983 prices of irrigation equipment and production inputs and a soybean price of $6.00 per bushel.

Seasonal average soybean prices for an eight-year period are presented in Table 3. These prices have averaged between $6.25 per bushel for the eight-year period to $6.52 per bushel for the most recent three years. A price of $6.00 per bushel for soybeans was selected on the basis that, if irrigation of soybeans becomes a widely accepted practice, soybean supplies would be greater during dry years.

Planting Date and Irrigation

The costs and returns to furrow irrigation of soybeans planted on two dates for three years are shown in Table 4. Soybeans were planted in mid-May and in late May or early June in each year on Sharkey clay. These soybeans were furrow irrigated beginning at bloom, and irrigation was continued until the end of the growing season. Irrigation water was applied when the soil water potential dropped to between -50 and -100 centibars as measured by a tensiometer at the 12-inch soil depth.

Large amounts of irrigation water were applied in all three years. Approximately 20 inches or more were applied to soybean plots in 1980, which was a relatively dry year. Early-planted soybeans (May 12) were irrigated six to seven times while late-planted soybeans (June 3) were irrigated five times. This large number of applications produced yield increases of 20 bushels per acre or more for all three varieties tested. In 1981 and 1982, plots were irrigated three to four times and more than 10 acre-inches of water per plot were applied with one exception. Yield increases were obtained from irrigation for both planting dates. However, in almost every case, irrigated mid-May-planted soybeans produced higher yield increases per acre than did irrigated soybeans planted in late May or early June.

Estimated direct and total irrigation costs are included in Table 4 for a furrow-irrigation system. Per acre costs of the gated-pipe system were estimated based on the inches of irrigation water applied. Early-planted soybeans had higher irrigation costs than later-planted soybeans due to a larger number of irrigations.

Returns to irrigation above estimated direct and total costs were obtained for all plots during the 1980 to 1982 period. Soybeans planted in mid-May and irrigated regularly from the beginning of bloom to the end of podfill generally had higher returns above estimated direct and total costs of irrigatio than did soybeans planted in lat May or early June and irrigated b the same guidelines. Returns abov direct and total irrigation costs fo the three-year period averaged abou $30.00 per acre higher for earl planted soybeans.

Yield increases required to cove furrow-irrigation costs are show in Table 5. Yield increases necessar to cover fixed costs of irrigatio were 4.1 bushels per acre for th gated-pipe system. With a direct o operating cost of $2.94 per acre inch, yield increases necessary t cover the direct costs were about 0. bushel per acre-inch applied.

The yield increases necessary t recover the cost of applying relative ly large volumes of irrigation wate are presented in Table 5. In 198 the total volume of irrigation wate applied to soybeans ranged fro 18.40 to 27.15 inches. Yield increase necessary to recover the direct cost of applying this volume of wate ranged from 9.0 to 15.1 bushels fo the gated-pipe system. Less tota water was applied in 1981 and 198 and the yield increases required t recover direct irrigation costs i these years ranged from 3.8 to 7. bushels per acre.

Timing of Irrigation

Timing of irrigation is ver important in obtaining a maximun soybean yield response to irrigation Soybean yield increases from irri gating at different stages of plan maturity were measured for thre

varieties grown on Sharkey clay. Four irrigation treatments were included in the test---irrigation started before bloom (PB), irrigation started at the beginning of bloom (BL), irrigation started at the beginning of podset (PS) and irrigation started at the beginning of podfill (PF). The irrigation costs and increased returns of these treatments are shown in Table 6.

Two irrigation treatments were conducted in 1979 on Bedford, Tracy, and Bragg soybeans. Irrigation was started at the beginning of podset or at the beginning of podfill and continued for the remainder of the growing season as needed. However, five of the six trials did not produce any substantial yield increase due to relatively large amounts of and more evenly distributed rainfall during the 1979 growing season. Only one treatment produced a return above irrigation costs in 1979.

In 1980, three irrigation treatments were conducted on each variety tested. Irrigation applications were started at the beginning of bloom, podset and podfill on Bedford soybeans and before bloom, at the beginning of bloom, and at the beginning of podfill on Tracy and Bragg varieties. Some of these plots were irrigated seven to eight times. Total irrigation water applied ranged from 11.55 to 27.45 acre-inches depending upon when irrigation was started. All three varieties showed a greater yield response to irrigation when applications were started at the earliest stage. As initial applications were delayed to later reproductive stages, the yield increase due to irrigation declined. Irrigation treatments started before or at the beginning of bloom increased irrigation costs over the podset and podfill treatments due to irrigating over a longer period of time, but returns above estimated direct and total costs were much greater when irrigation was started before or at bloom rather than at the beginning of podset or podfill. Returns per acre above estimated direct costs for the gated-pipe system ranged from $79.24 to $118.50 per acre for the PB treatment, from $57.53 to $101.13 per acre for the BL treatment and were $34.60 per acre for the PS treatment. Returns above total cost were negative for all PF treatments in 1980.

Yield increases necessary to cover estimated costs of irrigation started at different stages of plant growth are presented in Table 7. When irrigation was started at earlier plant stages and continued throughout the growing season, yield increases required to recover irrigation costs became larger as a result of the increased cost of applying more water over longer periods of time. Yield increases necessary to recover the direct cost of applying the volumes of water presented in Table 7 in 1983 with a gated-pipe system ranged from 5.7 to 13.5 bushels per acre. The total costs of applying these volumes of water required yield increases ranging from 9.7 to 17.5 bushels per acre to recover the total costs of the gated-pipe system based on a soybean price of $6.00 per bushel.

The effect of irrigation timing on yield response of soybeans grown on a silt loam soil is shown in Table 8. 'Forrest' soybeans were grown on Dubbs silt loam and irrigated by a sprinkler system. As indicated earlier, due to the amount and distribution of rainfall during the growing season, application of irrigation water resulted in only a minor yield increase in 1979.

The effect of beginning irrigation early during a dry year or during periods of inadequate soil moisture was evident in 1980. A yield response to irrigation of 27.6 bushels per acre was recorded when irrigation was started at the beginning of bloom. Yield response decreased to 20.2 bushels when irrigation was delayed until podset and to 19.7 bushels when irrigation was delayed until podfill. Returns above estimated direct and total costs of a center-pivot system were more than $30.00 per acre higher when irrigation was started at the beginning of bloom as compared to later initial applications. Break-even yield increases for these tests are included in Table 9.

Method of Irrigation

The two basic types of irrigation systems used on row crops are surface and overhead. The gated-pipe system is one of the major types of surface systems used to irrigate soybeans in the Delta. Center-pivot systems are the most common type of overhead system found on farms in the Delta. This section presents economic aspects of using these systems to irrigate soybeans.

Tests were conducted using the 'Tracy-M' and 'Centennial' varieties at the MAFES Delta Branch in 1981 and 1982. These varieties were irrigated by both furrow and sprinkler methods to determine the yield increase associated with using these different methods of irrigation. Two irrigation treatments were used in this study. One treatment consisted of irrigation water being applied using each irrigation method whenever the soil water potential at the 12-inch soil depth dropped to between -50 and -100 centibars as measured by a tensiometer (T12). Another group of soybeans was irrigated using each method according to the soil water potential at the 24-inch soil depth (T24). Results of these tests, along with the associated estimated costs and returns of the different irrigation methods, are presented in Table 10.

Soybean yield response to irrigation was positive for both methods of irrigation. Yield increases from irrigation were higher on the furrow-irrigated plots than on the sprinkler-irrigated plots for both the T12 and T24 treatments in 1981 and on furrow-irrigated plots for the T12

treatment in 1982. The T24 treatment resulted in approximately the same yield response for both the furrow and sprinkler methods in 1982. Break-even yield increases associated with these treatments are included in Table 11.

Row Spacing and Irrigation

Tracy soybeans were planted in 20-inch and 40-inch rows on Sharkey clay in 1980. Three irrigation treatments and a non-irrigated check were included in this study. Irrigation was started just before bloom (PB) as one treatment and continued throughout the season as needed. Irrigation applications for the other treatments were started at the beginning of bloom (BL) and at the beginning of podfill (PF). Soybeans receiving the PB and BL treatments were irrigated six to eight times. The PF treatment received two applications of irrigation water.

Yield response data (Table 12) indicate higher yield increases for irrigated soybeans planted in 20-inch rows than for soybeans planted in 40-inch rows when irrigation was started at the late vegetative (PB) and early reproductive (BL) stages. Estimated direct and total irrigation costs of the gated-pipe system on narrow rows is approximately equal to or greater than irrigation costs on wide rows, but returns above estimated direct and total costs were greater for soybeans planted on narrow rows as opposed to wide rows in 1980, which was a relatively dry year. Yield increases required to recover estimated costs are presented in Table 13.

The effect of row spacing on irrigated soybeans grown on a silt loam soil is presented in Tables 14 and 15. Forrest soybeans were planted in 20-inch and 40-inch rows on Dubbs silt loam. Irrigation water was applied by the sprinkler method. Yield increases for irrigated soybeans versus the non-irrigated check were recorded for both row spacings. The yield of soybeans planted in narrow rows was 10.0 bushels greater than that for soybeans planted in coventional (40-inch) rows in 1981. Yields observed in 1982 did not indicate any major yield increase due to row spacing. Hence, based on 1981 and 1982 results for Forrest soybeans planted on Dubbs silt loam, row spacing results were not consistent.

The economic feasibility of applying relatively large amounts of irrigation water with a sprinkler system is illustrated in Table 15. In 1981, soybeans planted on wide rows were irrigated seven times with a total of 10.75 inches of water. Soybeans planted on narrow rows were irrigated eight times with a total of 12.80 inches of water. Estimated direct irrigation costs for a center-pivot system were $27.95 and $33.28 per acre, respectively. Yield increases required to cover these direct costs were 4.7 bushels per acre on wide rows and 5.5 bushels per acre on narrow rows. In 1982, both row spacings were irrigated six times with a total of 7 inches. Direct costs for these applications were $18.20 per acre, resulting in a required break-even yield increase of about 3.0 bushels per acre. The required yield increase to recover estimated total cost of a center-pivot system ranged from 14.0 to 16.5 bushels per acre over the two year period.

In 1981 and 1982, Bedford, Tracy-M and Braxton varieti were planted in 20-inch and 40-inc rows on Sharkey clay. These so beans were irrigated two to fo times according to the soil wat potential at the 12-inch (T12) an the 24-inch (T24) soil depth. Est mated irrigation costs, returns an yield increases for these tests a shown in Table 16. Although yiel increases were recorded for all plot no consistent differences in return to irrigation of soybeans planted i narrow rows versus wide rows wer observed during 1981 and 1982.

A larger total volume of irrigatio water was applied with the T1 treatment than with the T24 trea ment. Total irrigation water applie by the furrow method with the T1 treatment ranged from 10 to 2 inches. Furrow applications of wate for the T24 treatment were some what less. As a result, estimate direct and total irrigation costs wer greater when irrigation was base on the soil water potential at th 12-inch depth. However, yield in creases were consistently highe and, in two-thirds of the cases returns above estimated direct an total costs were greater for soybean receiving the T12 irrigation treat ment than for soybeans receiving the T24 irrigation treatment. The low yield response (7.4 and 5.4 bushels) and negative returns shown for the T24 treatment and both row spacings of Tracy-M in 1982 (Table 16) were the result of this treatment being inadvertently skipped on an August 27 watering and then being watered with 7.90 inches on September 9 to try to compensate for the omitted irrigation. This result reinforces the need for timely irrigation of soybeans.

LIMITATIONS OF THE STUDY

Results of this study are based upon yield response of soybeans to irrigation on experimental plots, but they should be transferable to actual large field conditions. Production practices, other than irrigation practices, within the plots were the same as generally followed by better producers. In addition, a full-scale center-pivot irrigation system was not used in the irrigation tests on which this study was based. However, these results should be indicative of relative soybean yield response when irrigation practices are performed in a timely manner and based upon soil moisture potential.

Table 1. Estimated costs of a center-pivot system irrigating 130 acres on one pivot point, Mississippi Delta, 1983.

Item	Investment	Est. life	Annual costs
Fixed costs			
Engine	$ 6,000	15	$ 400.00
Well, pump, gearhead	12,000	20	600.00
Generator	2,150	10	215.00
Fuel tank and lines	1,000	15	80.00
Pivot system (1/4 mile)	38,000	15	2,533.33
Total investment	$59,150		
Average annual interest			4,140.50
Insurance			591.50
Total annual fixed costs			$8,560.33
Annual fixed cost per acre			$ 65.85

Direct costs	Per revolution	Per acre - inch
Engine repairs at 70% of new cost	$ 26.00	$ .20
Diesel fuel at $1.15/gal.	297.57	2.29
Oil at $4.00/gal.	3.46	.03
Maintenance labor at $4.40/hr.	11.07	.08
Total direct costs	$338.10	$2.60

Table 2. Estimated costs of a gated-pipe system irrigating 160 acres, Mississippi Delta, 1983.

Item	Investment	Est. life	Annual costs
Fixed costs			
Engine	$ 6,500	15	$ 433.33
Well, pump, gearhead	13,500	20	675.00
Fuel tank and lines	1,000	20	50.00
8" Gated pipe at $3.00/ft.	7,920	15	528.00
Total investment	$28,920		
Average annual interest			2,024.40
Insurance			200.00
Total annual fixed costs			$3,910.73
Annual fixed cost per acre			$ 24.44

Direct costs	4 inches per acre	Approximate costs per acre-inch
Engine repairs at 70% of new cost	$ .50	$ .13
Diesel fuel at $1.15/gal.	6.98	1.75
Oil at $4.00/gal.	.04	.01
Tractor fuel at $1.15/gal. (25 hrs. of operation)	.36	.09
Labor at $4.40/hr.	2.85	.71
Pipe replacement (2% of original pipe investment)	.99	.25
Total direct costs	$11.73	$2.94

Table 3. Seasonal yearly average price received per bushel of soybeans in Mississippi, 1975-82[1/].

Year	Seasonal price
	dollars/bushel
1975	4.81
1976	6.42
1977	6.18
1978	6.63
1979	6.37
1980	7.75
1981	6.25
1982	5.55
8-year average[2/]	6.25
Most recent 3-year average[3/]	6.52

1/ Source: Mississippi Crop and Livestock Reporting Service, Mississippi Agricultural Statistics, selected issues.

2/ Average of seasonal average price over the period.

3/ Average of seasonal average price for 1980, 1981 and 1982.

Table 4. Yield increase, estimated direct and total furrow-irrigation costs and estimated returns above direct and total irrigation costs of irrigated soybeans planted on two dates on Sharkey clay at the MAFES Delta Branch, 1980-1982.

Year	Planting date	Variety	Amount[1/] of water applied	Yield[2/] increase	Direct cost[3/] per acre	Total cost[3/] per acre	Returns above[4/] direct cost	Returns above[4/] total cost
			inches	bushels	dollars			
1980	May 12	Bedford	20.90	25.9	61.45	85.89	93.95	69.51
		Tracy	24.70	27.0	72.62	97.06	89.38	64.94
		Bragg	27.15	32.5	79.82	104.26	115.18	90.74
	June 3	Bedford	19.10	29.7	56.15	80.59	122.05	97.61
		Tracy	21.25	20.2	62.48	86.92	58.72	34.28
		Bragg	18.40	21.8	54.10	78.54	76.70	52.26
1981	May 13	Bedford	12.65	26.7	37.19	61.63	123.01	98.57
		Braxton	16.55	33.4	48.66	73.10	151.74	127.30
	June 4	Bedford	7.70	19.7	22.64	47.08	95.56	71.12
		Braxton	11.55	18.5	33.96	58.40	77.04	52.60
1982	May 12	Bedford	11.55	18.9	33.96	58.40	79.44	55.00
		Braxton	15.40	25.4	45.28	69.72	107.12	82.68
	May 28	Bedford	11.55	11.7	33.96	58.40	36.24	11.80
		Braxton	11.55	17.3	33.96	58.40	69.84	45.40

1/ Irrigation water was applied when the soil water potential at the 12-inch depth dropped between -50 and -100 centibars.

2/ Yield increase equals yield of irrigated soybeans minus yield of soybeans for the non-irrigated check.

3/ Direct and total costs of irrigation were estimated based on 1983 prices and costs of using a gated-pipe system.

4/ Returns above direct and total costs were computed using a soybean price of $6.00 per bushel and estimated costs of applying the amount of water indicated by a gated-pipe system.

Table 5. Yield increase and estimated yield increase required to recover irrigation costs for furrow-irrigated soybeans planted on two dates on Sharkey clay at the MAFES Delta Branch, 1980-1982.

Year	Planting date	Variety	Amount of water applied[1/]	Yield increase[2/]	Yield increase[3/] required to recover	
					Direct cost	Total cost
			inches	bushels	-----bushels------	
1980	May 12	Bedford	20.90	25.9	10.2	14.3
		Tracy	24.70	27.0	15.1	16.2
		Bragg	27.15	32.5	13.3	17.4
	June 3	Bedford	19.10	29.7	9.4	13.7
		Tracy	21.25	20.2	10.4	14.5
		Bragg	18.40	21.8	9.0	13.1
1981	May 13	Bedford	12.65	26.7	6.2	10.3
		Braxton	16.55	33.4	8.1	12.2
	June 4	Bedford	7.70	19.7	3.8	7.8
		Braxton	11.55	18.5	5.7	9.7
1982	May 12	Bedford	11.55	18.9	5.7	9.7
		Braxton	15.40	24.4	7.5	11.6
	May 28	Bedford	11.55	11.7	5.7	9.7
		Braxton	11.55	17.3	5.7	9.7

1/ Irrigation water was applied whenever the soil water potential at the 12-inch soil depth dropped between -50 and -100 centibars.

2/ Yield increase equals yield of irrigated soybeans minus the yield of soybeans for the non-irrigated check.

3/ Break-even yield increases were based on a soybean price of $6.00 per bushel and estimated costs of applying the amount of water indicated by a gated-pipe system are presented in Table 4.

Table 6. Yield increase, estimated direct and total irrigation costs and estimated returns above direct and total irrigation costs of furrow-irrigated soybeans grown on Sharkey clay at the MAFES Delta Branch, 1979-1980.

Year	Variety	Irrigation treatment[1/]	Amount of water applied	Yield increase[2/]	Direct cost[3/] per acre	Total cost[3/] per acre	Returns above direct cost[4/]	Returns above total cost
			inches	bushels	----------dollars----------			
1979	Bedford	PS	6.00	0.0	17.64	42.08	(17.64)	(42.08)
		PF	3.40	0.0	10.00	34.44	(10.00)	(34.44)
	Tracy	PS	6.85	0.2	20.14	44.58	(18.94)	(43.38)
		PF	5.80	0.0	17.05	41.49	(17.05)	(41.49)
	Bragg	PS	3.45	0.6	10.14	34.58	(6.54)	(30.98)
		PF	3.55	6.8	10.44	34.88	30.36	5.92
1980	Bedford	BL	18.80	18.8	55.27	79.71	57.53	33.09
		PS	19.25	15.2	56.60	81.04	34.60	10.16
		PF	13.90	5.6	40.87	65.31	(7.27)	(31.71)
	Tracy	PB	25.70	25.8	75.56	100.00	79.24	54.80
		BL	25.90	24.7	76.15	100.59	72.05	47.61
		PF	11.55	4.7	33.96	58.40	(5.76)	(30.20)
	Bragg	PB	27.45	33.2	80.70	105.14	118.50	94.06
		BL	22.95	28.1	67.47	91.91	101.13	76.69
		PF	11.55	6.9	33.96	58.40	7.44	(17.00)

1/ Application of irrigation water started prior to bloom (PB), beginning of bloom (BL), beginning of podset (PS) and beginning of podfill (PF).

2/ Yield increase equals the yield of irrigated soybeans minus the yield of soybeans for the non-irrigated check.

3/ Direct and total costs of irrigation were estimated based on 1983 prices and estimated costs of applying the amount of water indicated by a gated-pipe system.

4/ Returns above direct and total costs were computed using a soybean price of $6.00 per bushel and estimated cost of applying the amount of water indicated by a gated-pipe system. Items enclosed in parentheses represent negative returns or loss.

able 7. Yield increase and estimated yield increase required to recover irrigation osts for furrow-irrigated soybeans planted on Sharkey clay at the MAFES Delta Branch, 979-1980.

ear	Variety	treatment	Amount of water applied[1/]	Yield increase[2/]	Yield increase[3/] required to recover	
					Direct cost	Total cost
			inches	bushels	------bushels------	
1979	Bedford	PS	6.00	0.0	2.9	7.0
		PF	3.40	0.0	1.7	5.7
	Tracy	PS	6.85	0.2	3.4	7.4
		PF	5.80	0.0	2.8	6.9
	Bragg	PS	3.45	0.6	1.7	5.8
		PF	3.55	6.8	1.7	5.8
1980	Bedford	BL	18.80	18.8	9.2	13.3
		PS	19.25	15.2	9.4	13.5
		PF	13.90	5.6	6.8	10.9
	Tracy	PB	25.70	25.8	12.6	16.7
		BL	25.90	24.7	12.7	16.8
		PF	11.55	4.7	5.7	9.7
	Bragg	PB	27.45	33.2	13.5	17.5
		BL	22.95	28.1	11.2	15.3
		PF	11.55	6.9	5.7	9.7

1/ Application of irrigation water started prior to bloom (PB), beginning of bloom (BL), beginning of podset (PS) and beginning of podfill (PF).

2/ Yield increase equals the yield of irrigated soybeans minus the yield of soybeans for the non-irrigated check.

3/ Break-even yield increases were based on a soybean price of $6.00 per bushel and estimated costs of applying the amount of water indicated by a gated-pipe system presented in Table 6.

Table 8. Yield increase, estimated direct and total center-pivot irrigation cost and estimated returns above direct and total cost of irrigated Forrest soybeans grown on Dubbs silt loam at the MAFES Delta Branch, 1979-1980.

Year	Irrigation[1/] treatment	Amount of water applied	Yield[2/] increase	Direct cost[3/] per acre of a center pivot system	Total cost[3/] per acre of a center pivot system	Returns above[4/] direct cost	Returns above[4/] total cost
		inches	bushels	----------dollars----------			
1979	PF	3.00	1.7	7.80	73.65	2.40	(63.45)
1980	BL	12.15	27.6	31.59	97.44	134.01	68.16
	PS	9.05	20.2	23.53	89.38	97.67	31.82
	PF	6.75	19.7	17.55	83.40	100.65	34.80

1/ Application of irrigation water started at beginning of bloom (BL), beginning of podset (PS) and beginning of podfill (PF).

2/ Yield increase equals yield of irrigated plots minus the yield of non-irrigated check.

3/ Direct and total costs were estimated based on 1983 prices and costs of applying the amount of water indicated.

4/ Returns above direct and total costs were computed using a soybean price of $6.00 per bushel. Items enclosed in parentheses represent negative returns or loss.

NOTE: Tests were conducted using a fixed sprinkler system.

Table 9. Yield response and estimated yield increase required to recover center-pivot irrigation costs for Forrest soybeans grown on Dubbs silt loam at the MAFES Delta Branch, 1979-1980.

Year	Irrigation treatment[1/]	Amount of water applied	Yield increase[2/]	Yield increase required to recover[3/] Direct cost	Yield increase required to recover[3/] Total cost
		inches	bushels	bushels	bushels
1979	PF	3.00	1.7	1.3	12.3
1980	BL	12.15	27.6	5.3	16.2
	PS	9.05	20.2	3.9	14.9
	PF	6.75	19.7	2.9	13.9

1/ Application of irrigation water started at beginning of bloom (BL), beginning of podset (PS) and beginning of podfill (PF).

2/ Yield increase equals yield of irrigated plot minus yield of non-irrigated check.

3/ Break-even yield increases were based on a soybean price of $6.00 per bushel and the cost of applying the amount of water indicated by a center-pivot system presented in Table 8.

NOTE: Tests were conducted using a fixed sprinkler system.

Table 10. Irrigation application, yield increase, direct and total irrigation cost and returns above direct and total irrigation cost of soybeans irrigated by different methods on Sharkey clay at the MAFES Delta Branch, 1981-1982.1/

Year	Irrigation treatment[1/]	Amount of water applied		Yield increase[2/]		Direct cost per acre[3/]		Total cost per acre[3/]		Returns above direct cost[4/]		Returns above total cost[4/]	
		Sprinkler	Furrow	Sprinkler	Furrow	Center pivot	Gated pipe	Center pivot	Gated pipe	Center pivot	Gated pipe	Center pivot	Gated pipe
		inches		bushels		dollars							
1981	T12	6.70	12.75	24.5	26.3	17.42	37.49	83.27	61.93	129.58	120.31	63.73	95.87
	T24	4.80	7.75	17.5	23.4	12.48	22.79	78.33	47.23	95.52	117.61	26.67	93.17
1982	T12	3.15	4.60	3.5	11.0	8.19	13.52	74.04	32.96	12.81	52.48	(53.04)	28.04
	T24	1.75	2.75	3.8	3.3	4.55	8.09	70.40	32.53	18.25	11.71	(47.60)	(12.73

1/ Irrigation water was applied whenever the soil water potential at the 12-inch (T12) and 24-inch (T24) soil depth dropped between -50 and -100 centibars.

2/ Varieties tested were Tracy-M and Centennial. Yield increase equals irrigated yield minus non-irrigated yield.

3/ Direct and total costs of irrigation were estimated based on 1983 prices and costs of applying the amount of water indicated.

4/ Returns above direct and total costs were computed using a soybean price of $6.00 per bushel. Items enclosed in parentheses represent negative returns or loss.

NOTE: Tests were conducted using a fixed sprinkler system and a gated-pipe system.

Table 11. Irrigation application, yield increase and yield increase required to recover irrigation costs of soybeans irrigated by different methods on Sharkey clay at the MAFES Delta Branch, 1981-1982.

Year	Irrigation Treatment[1]	Amount of water applied		Yield increase[2]		Yield increase required to recover[3]: Direct cost		Yield increase required to recover[3]: Total cost	
		Sprinkler	Furrow	Sprinkler	Furrow	Center pivot	Gated pipe	Center pivot	Gated pipe
		-----inches-----		----bushels-----		----------bushels----------			
1981	T12	6.70	12.75	24.5	26.3	2.9	6.2	13.9	10.3
	T24	4.80	7.75	17.5	23.4	2.1	3.8	13.1	7.9
1982	T12	3.15	4.60	3.5	11.0	1.4	2.3	12.3	6.3
	T24	1.75	2.75	3.8	3.3	0.8	1.3	11.7	5.4

1/ Irrigation water was applied whenever the soil water potential at the 12-inch (T12) and the 24-inch (T24) soil depth dropped between -50 and -100 centibars.

2/ Varieties tested were Tracy-M and Centennial. Yield increase equals irrigated yield minus non-irrigated yield.

3/ Break-even yield increases were based on a soybean price of $6.00 per bushel and the cost of applying the amount of water indicated by the appropriate system presented in Table 10.

NOTE: Tests were conducted using a fixed sprinkler system and a gated-pipe system.

Table 12. Irrigation application, yield increase, estimated direct and total furrow-irrigation cost and estimated returns above direct and total irrigation cost for irrigated Tracy soybeans grown in two row spacings on Sharkey clay at the MAFES Delta Branch, 1980.

Year	Irrigation treatment[1]	Row spacing	Amount of water applied	Yield increase[2]	Direct cost per acre[3]	Total cost per acre[3]	Returns above direct cost[4]	Returns above total cost[4]
		inches	inches	bushels	----------dollars----------			
1980	PB	40	24.55	26.4	72.18	96.62	86.22	61.78
		20	28.95	36.5	85.11	109.55	133.89	109.45
	BL	40	22.35	22.5	65.71	90.15	69.29	44.85
		20	23.35	29.5	68.65	93.09	108.35	83.91
	PF	40	11.65	6.1	34.25	58.69	2.35	(22.09)
		20	11.55	7.4	33.96	58.40	10.44	(14.00)

1/ Application of irrigation water began prior to bloom (PB), beginning of bloom (BL), and beginning of podfill (PF).

2/ Yield increase equals irrigated yield minus non-irrigated yield.

3/ Direct and total irrigation costs were estimated based on 1983 prices and costs of applying the amount of water indicated.

4/ Returns above direct and total costs were computed using a soybean price of $6.00 per bushel and costs of applying the amount of water indicated by a gated-pipe system. Items enclosed in parentheses represent negative returns or loss.

Table 13. Irrigation application, yield increase and yield increase required to recover irrigation costs for furrow-irrigated Tracy soybeans grown in two row spacings on Sharkey clay at the MAFES Delta Branch, 1980.

Year	Irrigation treatment[1]	Row spacing	Amount of water applied	Yield increase[2]	Yield increase required to recover[3]	
					Direct Cost	Total Cost
		inches	inches	bushels	-----bushels------	
1980	PB	40	24.25	24.6	12.0	16.1
		20	28.95	36.5	14.2	18.3
	BL	40	22.35	22.5	11.0	15.0
		20	23.35	29.5	11.4	15.5
	PF	40	11.65	6.1	5.7	9.8
		20	11.35	7.4	5.7	9.7

1/ Application of irrigation water started prior to bloom (PB), beginning of bloom (BL), and beginning of Podfill (PF).

2/ Yield increase equals irrigated yield minus yield of the non-irrigated check.

3/ Break-even yield increases were based on a soybean price of $6.00 per bushel and costs of applying the amount of water indicated by a gated-pipe system.

Table 14. Irrigation application, yield increase, estimated direct and total center-pivot irrigation cost and estimated returns above direct and total cost of irrigated Forrest soybeans grown in two row spacings on Dubbs silt loam at the MAFES Delta Branch, Station, 1981-1982.

Year	Row spacing	Amount of water applied[1]	Yield increase[2]	Direct cost per acre of a center pivot system[3]	Total cost per acre of a center pivot system[3]	Returns above direct cost[4]	Returns above total cost[4]
	inches	inches	bushels	----------dollars----------			
1981	40	10.75	4.6	27.95	93.80	(0.35)	(66.20)
	20	12.80	14.6	33.28	99.13	54.32	(11.53)
1982	40	7.00	17.5	18.20	84.05	86.80	20.95
	20	7.00	16.1	18.20	84.05	78.40	12.55

1/ Irrigation water was applied whenever the soil water potential of the 12-inch soil depth dropped between -50 and -100 centibars.

2/ Yield increase equals irrigated yield minus non-irrigated yield.

3/ Direct and total costs of irrigation were estimated based on 1983 prices and the costs of applying the amount of water indicated.

4/ Returns above direct and total cost were computed using a soybean price of $6.00 per bushel. Items enclosed in parentheses represent negative returns or loss.

NOTE: Tests were conducted using a fixed sprinkler system.

Table 15. Irrigation application, yield increase and yield increase required to recover center-pivot costs of irrigated Forrest soybeans grown in two row spacings on Dubbs silt loam at the MAFES Delta Branch, 1981-1982.

Year	Row Spacing	Amount of water applied [1]	Yield [2] Response	Yield increase required to recover [3]	
				Direct cost	Total cost
	inches	inches	bushels	------bushels-------	
1981	40	10.75	4.6	4.7	15.6
	20	12.80	14.6	5.5	16.5
1982	40	7.00	17.5	3.0	14.0
	20	7.00	16.1	3.0	14.0

1/ Irrigation water was applied whenever the soil water potential at the 12-inch soil depth dropped between -50 and -100 centibars.

2/ Yield increase equals irrigated yield minus non-irrigated yield.

3/ Break-even yield increases were based on a soybean price of $6.00 per bushel and costs of applying the amounts of water indicated by a center-pivot system.

NOTE: Tests were conducted using a fixed sprinkler system.

Table 16. Irrigation application, yield increase, estimated direct and total furrow-irrigation cost and estimated returns above direct and total irrigation cost of irrigated soybeans grown in two-row spacings on Sharkey clay at the MAFES Delta Branch, 1981-1982.

Year	Irrigation treatment [1]	Row spacing	Variety	Amount of water applied	Yield [2] increase	Direct cost [3] per acre	Total cost [3] per acre	Returns above [4] direct cost	Returns above [4] total cost
		inches		inches	bushels	----------dollars----------			
1981	T12	40	Bedford	14.60	24.8	42.92	67.36	105.88	81.44
			Tracy-M	15.60	23.7	45.86	70.30	96.34	71.90
			Braxton	16.15	20.3	47.48	71.92	74.32	49.88
		20	Bedford	17.15	23.3	50.42	74.86	89.38	64.94
			Tracy-M	17.20	23.2	50.57	75.01	88.63	64.19
			Braxton	17.45	17.9	51.30	75.74	56.10	31.66
	T24	40	Bedford	11.70	19.0	34.40	58.84	79.60	55.16
			Tracy-M	8.00	19.9	23.52	47.96	95.88	71.44
			Braxton	8.95	15.4	26.31	50.75	66.09	41.65
		20	Bedford	14.50	23.7	42.63	67.07	99.57	75.13
			Tracy-M	10.25	22.0	30.14	54.58	101.86	77.42
			Braxton	10.45	15.8	30.72	55.16	64.08	39.64
1982	T12	40	Bedford	11.55	16.1	33.96	58.40	62.64	38.20
			Tracy-M	15.40	14.3	45.28	69.72	40.52	16.08
			Braxton	16.65	20.2	48.95	73.39	72.25	47.81
		20	Bedford	16.55	16.0	33.96	58.40	62.04	37.60
			Tracy-M	16.75	22.2	49.25	73.69	83.95	59.51
			Braxton	19.25	19.2	56.60	81.04	58.60	34.16
	T24	40	Bedford	7.70	10.0	22.64	47.08	37.36	12.92
			Tracy-M	7.70	7.4	22.64	47.08	21.76	(2.68)
			Braxton	7.70	13.9	22.64	47.08	60.76	36.32
		20	Bedford	9.90	13.3	29.11	53.55	50.69	26.25
			Tracy-M	13.70	5.4	40.28	64.72	(7.88)	(32.32)
			Braxton	9.85	13.5	28.96	53.40	52.04	27.60

1/ Irrigation water was applied whenever the soil water potential at the 12-inch (T12) and 24-inch (T24) soil depth dropped between -50 and -100 centibars.

2/ Yield increase equals irrigated yield minus non-irrigated yield.

3/ Direct and total costs were estimated based on 1983 prices and costs of applying the amount of water indicated by a gated-pipe system.

4/ Returns above direct and total costs were computed using a soybean price of $6.00 per bushel. Items enclosed in parentheses represent negative returns or loss.

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Postemergence Herbicide Treatments for Control of Johnsongrass in Soybeans

With and Without Preplant Soil Incorporated and Preemergence Herbicides

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Postemergence Herbicide Treatments for Control of Johnsongrass in Soybeans

With and Without Preplant Soil Incorporated and Preemergence Herbicides

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Postemergence Herbicide Treatments for Control of Johnsongrass in Soybeans

With and Without Preplant Soil Incorporated and Preemergence Herbicides

Johnsongrass [*Sorghum halepense* (L.) Pers.] continues to rank high as a problem weed in Mississippi soybean fields despite improved techniques for control (6). The application of preplant soil-incorporated dinitroaniline herbicides at twice (2X) the normal rate (X), glyphosate applied either with the recirculating sprayer or rope-wick applicator and treatments with newly developed, selective over-the-top herbicides have improved the control of rhizome johnsongrass in soybean fields (1,2,3,4,9,10). However, low-level johnsongrass infestations continue in soybean fields where farmers are using the best weed management programs available. Previous studies have shown the value of applying herbicides as spot sprays for control of johnsongrass (5,7,8,11,12).

We report the results of studies conducted at the MAFES North Mississippi Branch to evaluate the benefits of applying glyphosate (Roundup®) with the rope-wick applicator and spot spraying selective over-the-top grass herbicides to low-level rhizome johnsongrass infestations. The trial was on plots that previously had been treated with preplant incorporated herbicides at the 2X rate for two consecutive years, followed by one year at the X rate (see footnotes 1 and 2, Table 1).

Methods and Materials

The three-year trial (1980-82) was conducted on a silt loam (16.4% sand, 70.4% silt, 13.2% clay) with 0.8% organic matter and pH of 6.2. The design was a split plot with four replications.

Main plots were 16 rows (30 ft long and 40 inches wide). The main plots (Table 1) were a control (no herbicide), preplant incorporated (PPI) treatment with Basalin® (fluchloralin), Treflan® (trifluralin) and Prowl® (pendimethalin) and preemergence (PRE) treatment with MBR 18337 (benzofluor). Each herbicide was applied broadcast at the X rate each spring. The PPI treatments were mixed 2 inches deep in the soil with a power-driven rotary tiller. Each main plot received the same treatment each year.

Subplots were four adjacent rows in each main plot, with one subplot serving as a control (no herbicide). The subplot treatments were Roundup applied with a tractor-mounted rope wick in 1980 and 1981 and a hand-held rope wick in 1982 and spot-spray applications of RO 13-8895 in 1980 and 1981, Verdict 2E® (haloxyfop) in 1982 and Poast 1.5 E® (sethoxydim) each year (Table 1).

Spot spraying was accomplished by hand treating 15- to 30-inch tall johnsongrass plants from a tractor-mounted seat. Two rows per pass were treated at speed of about 2 miles/hr.

Basagran 4E® at 0.75 lb/acre was applied 6/4/80, 6/21/81 and 6/4/82 to control broadleaf weeds. All row middles were cultivated as needed.

'Forrest' soybeans were planted in May each year. Recommended seedbed preparation, fertilization and other production practices were used. The two center rows of each subplot were combine harvested.

Time required and amounts of spray mixture used were recorded for the hand-applied spot treatments.

Results and Discussion

Johnsongrass infestations on main plots (averages of subplots) treated PPI with Basalin® and PRE with MBR 18337 were smaller ($P < .05$) than the control infestations before superimposed treatment in 1980 but did not differ from the control population after superimposed treatment (Table 3). Reduction in numbers of johnsongrass plants as the precent of numbers in the control was greatest for MBR 18337 before superimposed treatment in 1980 and 1982 and for Basalin before superimposed treatment in 1981 and after superimposed treatment each year.

The three-year average populations of johnsongrass on main plots (averages of subplots) did not differ from those in the control. The per-

centage reduction in numbers of johnsongrass plants was greatest for Basalin before and after superimposed treatment.

Populations of johnsongrass in subplots (averages of main plots) differed ($P < .05$) from those in the control before superimposed treatment in 1980 (Table 4), but differences among herbicide treatments were not significant. The percentage reduction in johnsongrass plants before superimposed treatment was greatest for Roundup in 1980 and Poast® in 1981 and 1982. Percentage reductions in johnsongrass populations after superimposed treatment were greatest for Poast in 1980, RO-8895 in 1981 and Verdict® in 1982.

The three-year average populations of johnsongrass on subplots (averages of main plots) did not differ ($P < .05$) from numbers in the control. The reduction in numbers of johnsongrass plants was greatest for Poast before and after superimposed treatment.

The johnsongrass populations in control plots declined from 223.5/120 row ft in September 1980 to 80.3/120 row ft in September 1981 and was down to 69.8/120 row ft in September 1982 (Table 2). We attribute these declines to cultivation and annual weather patterns.

The interactions of main-plot and subplot means are presented in Table 2 (by years) and Table 5 (three-year average). Johnsongrass populations on plots treated PPI with Basalin or PRE with MBR 18337 did not differ ($P < .05$) from those on the control. Plots treated PPI with Treflan had a population decrease of 83% from September 1980 to September 1981, followed by a 55% increase the next year. Johnsongrass populations on plots treated PPI with Prowl declined 65% from September 1980 to September 1981 but remained about the same at the end of the next year.

Spot treatments did not improve johnsongrass control on plots treated PPI with Basalin or PRE with MBR 18337 but gave significantly better johnsongrass control on plots that were treated PPI with Treflan or Prowl or were cultivated only.

The johnsongrass populations in September were much lower following spot treatment with RO 13-8895, Verdict or Poast, irrespective of whether a PPI or PRE herbicide was used. Roundup performed better after application of PPI or PRE herbicides.

Yields in 1981 were lowest ($P < .05$) where no PPI, PRE or superimposed herbicides were applied (Table 6). Yields on main plots (averages of subplots) were higher ($P < .05$) than yields on the main-plot control after PPI treatment with Basalin in 1982, but not higher than yields following PPI treatment with Treflan (Table 7). The three-year average main-plot yields did not differ.

Yields on subplots (averages main plots) were higher ($P < .$ than yields on the subplot cont where Roundup and RO 13-8 were superimposed in 1980 and superimposed treatments w applied in 1982 (Table 8). The thr year average yields following ea superimposed treatment w higher than yields on the subp control.

Slight to moderate (30 to 40 symptoms of injury to soybe plants were observed when MI 18337 was applied in mid-July, 19 The symptoms were shorter plan abnormally dark-green color, rou foliage texture and leaf cupping.

The time required for spot treati ranged from 0.33 hr/acre for R 13-8895 superimposed on ME 18337 in 1980 to 3 hrs/acre f Verdict without PPI or PRE tre ment in 1982 (Table 9). The amou of spray mix needed to spot tre ranged from 3.3 gal/acre for Poa superimposed on Basalin in 1981 51.2 gal/acre for RO 13-8895 supe imposed over the main-plot contr in 1980 (Table 10).

The time required and the amou of spray mix used in spot treatir varied considerably and was n proportional to the level of johnso grass infestation. It was estimat that less than 1 qt of mix (Roundu water; 1:2) was used with each rop wick application to a treated are of 600 row ft.

Summary

Johnsongrass was controlled more effectively by spot treating with Poast, RO 13-8895 or Verdict than by Roundup applied by rope wick, by preplant incorporated Basalin, Treflan or Prowl alone or by preemergence MBR 18337 alone.

Soybean yields were not affected by any herbicide treatment but were lowest when cultivation alone was used to control johnsongrass.

After three years, control of johnsongrass with MBR 18337 was as effective as with Basalin and was more effective than wit Treflan or Prowl. However, plar injury symptoms were apparer after treatment with MBR 18337 i the third year.

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Table 1. Preplant (PPI) and preemergence (PRE) treatments (main plots) and superimposed postemergence treatments (subplots) for herbicide control of rhizome johnsongrass in soybeans in trials at the MAFES North Mississippi Branch, 1980-82.

Main Plot Treatment	Rate	Subplot Treatment		
		Herbicide	Concentration	Dates Applied
	lbs/acre		% V/V	mo/day/year
Basalin 4E (PPI)[1]	0.75	Roundup 4E[3]	33.0	7/7, 9/9/80; 7/14/81; 7/7/82
Treflan 4E (PPI)[1]	0.75	RO 13-8895 3E[4]	1.6;1.0	6/10/80; 7/14/81
		Verdict 2E[4]	0.5	7/6/82
Prowl 4E (PPI)[1]	0.75	Poast 1.5E[5]	0.5	6/10/80; 7/14/81; 7/6/82
MBR 18337 2E (PRE)[2]	0.50	None		-

[1]Applied 5/19/80, 6/11/81 and 5/18/82 and incorporated 2 inches deep with a rotary power incorporator. Each main-plot herbicide treatment followed the same herbicide applied at 1.5 lbs/acre in November 1976 and 1977 and double-disk incorporated and at 0.75 lb/acre in June 1979 incorporated 2 inches deep with a rotary power incorporator.

[2]Applied 5/19/80, 6/11/81 and 5/18/82. Tolban 4E® had been applied at 1.5 lbs/acre in November 1976 and 1977 and double-disked incorporated and at 0.75 lb/acre in June 1979 incorporated 2 inches deep with a rotary power incorporator.

[3]Applied in two directions with a tractor-mounted rope wick in 1980 and 1981 at a hand-held rope wick in 1982.

[4]Applied in water at the concentration indicated, with two rows per pass sprayed by hand from a tractor-mounted seat. Surfactant added to spray mixture at 0.5% v/v. Development of RO 13-8895 discontinued after 1981.

[5]Applied in water at the concentration indicated, with two rows per pass sprayed by hand from a tractor-mounted seat. Petroleum oil (83%)-surfactant (17%) blend added to spray mixture at 0.625% v/v in 1980 and at 1.25% v/v in 1981 and 1982.

Table 2. Numbers of johnsongrass plants per 120 row ft in trials with preplant soil incorporated (PPI) and preemergence (PRE) treatments[1] (main plots) and superimposed treatments[1] (subplots) for herbicide control of rhizome johnsongrass in soybeans, before and after superimposed treatments, MAFES North Mississippi Branch, 1980-82.[2]

Main Plot Treatment	Number of rhizome johonsongrass plants per 120 row ft							
	Before treatment with				After treatment with			
	Roundup 4E	RO 13-8895 3E[3]	Poast 4E	None	Roundup 4E	RO 13-8895 3E	Poast 1.5E	None
	counted 6/4/80[4]				counted 9/16/80[4]			
Basalin 4E (PPI)	3.8	15.8	25.8	42.8	4.0	2.3	1.8	15.3b
Treflan 4E (PPI)	40.3	36.8	29.0	166.0	8.0 B	2.5 B	3.3 B	272.3aA
Prowl 4E (PPI)	11.3	37.3	52.5	93.0	2.8 B	5.0 B	4.8 B	94.8bA
MBR 18337 2S (PRE)	17.8	7.5	33.0	13.8	15.8	21.0	5.8	28.5b
None	79.0	73.3	60.5	179.5	42.0 B	2.3 B	1.0 B	223.5aA
	counted 7/13/8[4]				counted 9/25/81[4]			
Basalin 4E (PPI)	5.3 b	4.8	3.8	18.3c	5.3	1.0	1.0	17.5cd
Treflan 4E (PPI)	14.0abB	14.3 B	8.3 B	51.3bA	9.5 B	1.3 B	2.8 B	46.5bA
Prowl 4E (PPI)	3.8 bB	17.0 B	10.5 B	36.5bcA	5.3 B	1.3 B	1.5 B	33.3bcA
MBR 18337 2S (PRE)	10.3ab	14.0	7.3	19.3c	5.3	1.8	1.0	11.5d
None	26.0aB	22.5 B	20.3 B	81.8aA	17.8 B	2.3 B	1.8 B	80.3aA
	counted 6/30/82[4]				counted 9/7/82[4]			
Basalin 4E (PPI)	8.8 b	5.8 b	6.5	18.5c	4.0	1.3	2.0	16.5b
Treflan 4E (PPI)	17.8 bB	6.0 bB	9.5 B	59.3abA	7.5 B	0.5 B	2.5 B	72.3aA
Prowl 4E (PPI)	10.3 bB	7.0 bB	13.5 B	43.5bA	4.0 B	1.3 B	3.5 B	38.8abA
MBR 18337 2S (PRE)	7.8 b	6.0 b	4.8	2.3c	7.5	2.3	6.8	8.8 b
None	61.5aB	58.0aB	24.5 C	85.8cA	15.5 B	3.0 B	3.5 B	69.8aA

[1]See Table 1 for herbicide rates and application methods.
[2]'Forrest' soybeans planted 5/19/80, 6/11/81, 5/19/82. Basagran 4E at 0.75 lb/acre was applied 6/4/80, 6/21/81 and 6/4/82 to control broadleaf weeds. All row middles were cultivated as needed.
[3]Verdict 2E was substituted when development of RO 13-8895 4E was discontinued after 1981.
[4]Values in columns followed by a different lower case letter or in rows followed a different upper case letter differ (P = .05) according to Duncan's multiple range test.

Table 3. Numbers per 120 row ft and reduction in numbers of rhizome johnsongrasss plants in main plots (averages of superimposed treatments) after preplant (PPI) and preemergence (PRE) treatments (main plots) and superimposed treatments (subplots), before and after superimposed treatment, MAFES North Mississippi Branch, 1980-82.[1]

Main Plot Treatment	No. and reduction in No. of rhizome johnsongrass plants							
	Before superimposed treatment							
	7/13/80		6/4/81		6/30/82		Average	
	No.[2]	%[3]	No.[2]	%[3]	No.[2]	%[3]	No.[2]	%[3]
Basalin 4E (PPI)	22.0 b	78	8.0	79	9.9	83	13.3	79
Treflan 4E (PPI)	68.0ab	31	21.9	42	23.2	69	37.7	42
Prowl 4E (PPI)	48.5ab	51	16.9	55	18.6	68	28.0	57
MBR 18337 2S (PRE)	18.0b	82	13.0	65	5.2	91	12.1	81
None (control)	98.1a	--	37.6	--	57.4	--	64.4	--
	After superimposed treatment							
	9/16/80		9/23/81		9/7/82		Average	
	No.[2]	%[3]	No.[2]	%[3]	No.[2]	%[3]	No.[2]	%[3]
Basalin 43 (PPI)	5.8	91	6.2	76	6.0	74	6.0	84
Treflan 4E (PPI)	71.5	(14)[4]	15.0	42	20.7	10	35.7	3
Prowl 4E (PPI)	26.8	57	10.4	59	11.9	48	16.4	56
MBR 18337 2S (PRE)	17.8	71	4.9	81	6.3	73	9.7	74
None (control)	67.2	--	25.6	--	23.0	--	36.9	--

[1]Derived from Table 2.
[2]Number of rhizome johnsongrass plants per 120 row ft.
[3]Reduction in numbers as percent of numbers in control.
[4]Increase over control.

Table 4. Numbers per 120 row ft 12and reduction in numbers of rhizome johnsongrasss plants in subplots (averages of PPI and PRE treatments) after preplant (PPI) and preemergence (PRE) and superimposed treatments (subplots), before and after superimposed treatments, MAFES North Mississippi Branch , 1980-82.[1]

Subplot Treatment	No. and reduction in No. of rhizome johnsongrass plants							
	Before superimposed treatment							
	6/4/80		7/13/81		6/30/82		Average	
	No.[2]	%[3]	No.[2]	%[3]	No.[2]	%[3]	No.[2]	%[3]
Roundup 4E	30.4 b	69	11.9	71	21.2	49	21.2	65
RO 13-8895 3E	34.1 b	65	14.5	65				
Verdict 2E[4]					16.6	60	21.7	64
Poast 1.5E	40.2 b	59	10.0	76	11.8	72	20.6	66
None (control)	97.2 a	--	41.4	--	41.9	--	59.8	--
	After superimposed treatment							
	9/16/80		9/23/81		9/7/82		Average	
	No.[2]	%[3]	No.[2]	%[3]	No.[2]	%[3]	No.[2]	%[3]
Roundup 4E	14.5	89	8.6	77	7.7	81	10.3	85
RO 13-8895 3E	6.6	95	1.3	97				
Verdict 2E					1.7	96	3.3	95
Poast 1.5 E	3.3	97	2.1	94	3.7	91	2.8	96
None (control)	126.9	--	37.8	--	41.2	--	68.7	--

[1]Derived from Table 2.
[2]Number of rhizome johnsongrass plants per 120 row ft.
[3]Reduction in numbers as percent of numbers in control.
[4]Verdict 4E was substituted when development of RO 13-8895 4E was discontinued after 1981.

Table 5. Three-year average numbers per 120 row ft and reduction in numbers of johnsongrass plants in trials with preplant soil incorporated (PPI) and pre-emergence (PRE) treatments (main plots) and superimposed treatments (subplots) for herbicide control of rhizome johnsongrass in soybeans, before and after superimposed treatments, MAFES North Mississippi Branch, 1980-82.[1]

Main Plot Treatment	No. and reduction in No. of rhizome johnsongrass plants Before sumperimposed treatment with: Roundup 4E		RO 13-8895 3E[2]		Poast 1.5E		None (Control)	
	Before superimposed treatment[3]							
	No.[4]	%[5]	No.[4]	%[5]	No.[4]	%[5]	No.[4]	%[5]
Basalin 4E (PPI)	6.0 b	89	8.7 b	83	12.0a	66	26.5cd	76
Treflan 4E (PPI)	24.0 bB	57	19.0abB	63	15.6aB	56	92.2abA	17
Prowl 4E (PPI)	8.4 bB	85	20.4abAB	60	25.5aAB	27	57.7bcA	49
MBR 18337 2S (PRE)	11.9 b	79	9.2 b	82	15.0a	57	10.1d	10
None (control)	55.5 aB	--	51.3aB	--	35.1aB	--	10.1dA	--
	After superimposed treatment[3]							
Basalin 43 (PPI)	4.4	82	1.5	40	1.6	34	16.4 c	93
Treflan 4E (PPI)	8.4 B	66	1.5 B	40	2.8 B	(33)[4]	130.3aA	(5)[6]
Prowl 4E (PPI)	4.0 B	84	2.5 B	0	3.3 B	(57)[4]	56.0 bA	53
MBR 18337 2S (PRE)	9.5	62	8.8	(35)[6]	4.5	(114)[4]	163. c	87
None (control)	25.1 B	--	2.5 B	--	2.1 B	--	124.5aA	--

[1]Derived from Table 2.
[2]Verdict 4E was substituted when development of RO 13-8895 4E was discontinued after 1981.
[3]Values in columns followed by a different lower case letter or in rows followed by a different upper case letter differ (P = .05) according to Duncan's multiple range test.
[4]Number of rhizome johnsongrass plants per 120 row ft.
[5]Reduction in numbers as percent of numbers in control.
[6]Increase over control.

Table 6. Combine yields of soybeans in trials with preplant (PPI) and pre-emergence (PRE) treatments[1] (main plots) and superimposed treatments (sub-plots) for herbicide control of rhizome johnsongrass in soybeans, MAFES North Mississippi Branch, 1980-82.[2]

Main Plot Treatment	Combine yield[2]			
	Roundup 4E	RO 13-8895 3E[3]	Poast 1.5E	None
	bu/acre			
		1980		
Basalin 4E (PPI)	22.5	23.3	22.7	22.8
Treflan 4E (PPI)	26.9	26.6	23.6	22.0
Prowl 4E (PPI)	23.3	23.7	22.7	21.7
MBR 18337 2S (PRE)	20.3	19.7	19.6	20.3
None (control)	22.6	23.5	23.4	16.0
		1981		
Basalin 43 (PPI)	43.9	44.2	44.1	41.4
Treflan 4E (PPI)	48.7	45.7	49.5	44.0
Prowl 4E (PPI)	44.0	49.2	48.2	43.8
MBR 18337 2S (PRE)	45.6	41.5	42.3	42.7
None (control)	44.8A	48.2A	45.8A	35.6B
		1982		
Basalin 4E (PPI)	29.9	30.5	28.2	25.9
Treflan 4E (PPI)	25.7	30.4	28.0	21.9
Prowl 4E (PPI)	24.2	25.9	25.6	20.4
MBR 18337 2S (PRE)	24.9	25.1	22.6	20.7
None (control)	24.7	23.3	25.2	21.4
		Three-year average		
Basalin 43 (PPI)	31.4	31.9	31.0	29.3
Treflan 4E (PPI)	32.9	33.4	33.0	28.6
Prowl 4E (PPI)	29.8	32.2	31.5	28.0
MBR 18337 2S (PRE)	29.6	28.1	27.6	27.3
None (control)	30.0	30.9	30.8	23.7

[1]See footnote 1, Table 2.
[2]Values in a row followed by a different letter differ (P = .05) according to Duncan's mulitple range test.

Table 7. Combine yield of main plots (averages of superimposed treatments) in trials with preplant (PPI) and preemergence (PRE) treatments (main plots) and superimposed treatments (subplots), MAFES North Mississippi Branch, 1980-82.[1]

Main Plot Treatment	Combine yield[2]			
	1980	1981	1982	Average
	bu/acre			
Basalin 4E (PPI)	22.8	43.4	28.6a	31.6
Treflan 4E (PPI)	24.8	47.0	26.5ab	32.8
Prowl 4E (PPI)	22.8	46.3	24.0 b	31.0
MBR 18337 2S (PRE)	20.0	43.0	23.3 b	28.8
None (control)	21.4	43.6	23.6 b	29.5

[1]Derived from Table 6.
[2]Values in the same column followed by a different letter differ (P = .05) according to Duncan's multiple range test.

Table 8. Combine yield of subplots (averages of main plot treatments) in trials with preplant (PPI) and preemergence (PRE) treatments (main plots) and superimposed treatments (subplots), MAFES North Mississippi Branch, 1980-81.[1]

Subplot Treatment	Combine yield[2]			
	1980	1981	1982	Average
	bu/acre			
Roundup 4E	23.1a	45.4	25.9a	31.5a
RO 13-8895 3E[3]	23.4a	45.8	27.0a	32.1a
Poast 1.5 E	22.4ab	46.0	25.9a	31.4a
None (control)	20.6 b	41.5	22.1 b	28.1 b

[1]Derived from Table 6.
[2]Values in the same column followed by a different letter differ (P = .05) according to Duncan's multiple range test.
[3]Verdict 4E was used in 1982.

Table 9. Time required to spot treat light johnsongrass infestations in trials with preplant soil-incorporated (PPI) and preemergence (PRE) treatments (main plots) and superimposed treatments (subplots) for herbicide control of rhizome johnsongrass in soybeans, MAFES North Mississippi Branch, 1980-82.

	Time required for spot treating with					
	Poast 1.5 E			RO 13-8895		Verdict 2E
	1980	1981	1982	1980	1981	1982
	hrs/A[1]					
Basalin 4E (PPI)	0.60 (.36 - .88)	0.49 (.30 - .61)	1.45 (1.24 - 1.69)	0.39 (.30 - .48)	0.43 (.15 - .97)	1.44 (1.27 - 1.75)
Treflan 4E (PPI)	0.86 (.36 - 1.63)	0.65 (.55 - .70)	1.55 (1.27 - 1.85)	0.61 (.24 - 1.03)	0.70 (.55 - .85)	1.48 (.97 0 1.97)
Prowl 4E (PPI)	1.06 (.58 - 1.79)	0.64 (.45 - .85)	1.62 (1.24 - 2.33)	0.64 (.27 - 1.03)	0.79 (.58 - 1.00)	1.59 (1.27 - 1.94)
MBR 18337 2S (PRE)	0.42 (1.8 - 1.15)	0.51 (.30 - .70)	1.41 (1.18 - 1.60)	0.33 (.21 - .58)	0.59 (.21 - .97)	1.41 (1.15 - 1.57)
None	1.14 (1.12 - 1.27)	0.74 (.61 - .88)	1.94 (1.48 - 2.36)	1.28 (1.03 - 1.69)	0.92 (.70 - 1.06)	3.00 (2.21 - 3.93)

[1]Calculated from values recorded for each plot; average of 4 replications with (parentheses) indicating range.
[2]Applied preemergence.

Table 10. Amounts of spray solutions used in postemergence spot treatments of light johnsongrass infestations in soybeans in trials at the MAFES North Mississippi Branch, 1980-82.

	Amount of spray used with					
	Poast 1.5 E			RO 13-8895		Verdict 2E
	1980	1981	1982	1980	1981	1982
	gal/A[1]					
Basalin 4E (PPI)	7.5 (3.9 - 10.4)	3.3 (0 - 6.5)	4.9 (1.3 - 10.4)	14.0 (6.5 - 23.5)	3.9 (1.3 - 10.4)	6.8 (2.6 - 17.0)
Treflan 4E (PPI)	8.5 (3.9 - 17.0)	4.2 (1.3 - 7.8)	6.2 (1.3 - 9.1)	17.6 (1.3 - 61.3)	6.5 (1.3 - 15.7)	6.8 (2.6 - 11.7)
Prowl 4E (PPI)	13.7 (2.6 -23.5)	6.2 (3.9 - 9.1)	9.8 (2.6 - 18.3)	15.0 (7.8 - 27.4)	7.8 (1.3 - 14.4)	8.5 (1.3 - 15.7)
MBR 18337 2S (PRE)	11.1 (3.9 - 19.6)	6.5 (2.6 - 10.4)	11.4 (2.6 - 24.8)	20.2 (14.4 - 23.5)	10.4 (5.2 - 17.0)	8.8 (1.3 - 15.7)
None	36.8 (26.1 - 43.0)	9.5 (7.8 - 11.7)	16.0 (7.8 - 26.1)	51.2 (30.0 - 69.1)	11.7 (6.5 - 17.0)	33.9 (19.6 - 52.2)

[1]Calculated from weights before and after each plot assuming 1 gallon weight 8.35 pounds. Values are an average of 4 replications with parentheses indicating range.
[2]Applied preemergence.

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Cost-size Relationships in the Processing of Farm-raised Catfish in the Delta of Mississippi

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Cost - size Relationships in the Processing of Farm - raised Catfish in the Delta of Mississippi

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Cost - size Relationships in the Processing of Farm-raised Catfish in the Delta of Mississippi

The increase in commercial production and processing of farm-raised catfish in recent years has been dramatic. Water acres have increased by an average of 20% per year over the last 10 years. More than 65,000 acres of water were used in the production of farm-raised catfish in Mississippi in 1983 [3].[1] About 140 million pounds of farm-raised catfish (live-weight) were processed in 1983 [6], most of which was in the Delta area of Mississippi. The annual one-shift capacity of commercial processing plants in Mississippi increased from 8 million pounds in 1979 [5] to an estimated 200 million pounds in 1983.

The catfish industry has grown considerably, but its current size may be only a small proportion of its potential. The per capita consumption of fish and seafood in the United States was about 12.3 pounds annually in 1982 [7], with farm-raised catfish representing about 4% of total consumption. Small increases in per capita consumption likely will bring about large increases in production and processing in Mississippi. A one-pound increase in U.S. per capita catfish consumption would increase total quantity demanded by more than 400 million pounds (live-weight). Such increases will occur as catfish continue to capture a greater share of the market for fish.

Rapid growth in processing capacity generally has paralleled the growth in farm production. This expansion in processing capacity occurred with little published research information on the economics of catfish processing. Entrepreneurs have been handicapped by a lack of published information concerning cost-size relationships in catfish processing and costs associated with alternative processing technologies. Consequently, the annual one-shift capacity of commercial processing plants operating in 1983 varied from 7 to 48 million pounds live-weight and reflected a range in technology from highly labor intensive to almost fully automated. As the industry continues to grow and mature, it will become more critical that processing plants of the most efficient size be designed around the most efficient processing technologies available.

The market potential for farm-raised catfish cannot be assessed adequately without some understanding of the consumer demand for the product. In order to plan studies of consumer demand, it is important to know the total costs of placing the product in retail outlets, and it is evident that processing costs represent a significant portion of total costs.

Objectives

The overall objective of this study was to discover cost of processing farm-raised catfish and to discover if economies of size exist in the catfish processing industry.

The specific objectives of the study were to (1) identify alternative plant sizes and technologies that are believed to capture most size economies, (2) synthesize efficient catfish processing plants that correspond in size to the plants identified and to determine the costs of processing catfish by phases of the processing cycle for each plant size and (3) determine if economies of size exist by evaluating per-unit cost of processing for plants of different sizes.

[1] *Numbers in brackets refer to items cited by those numbers in References.*

Procedure

Objective 1 was achieved through the use of available information on the capacity of the processing plants in the Delta. From this information alternative plant sizes that generally encompass the plant sizes existing in the Delta were designated. Also, from available information as well as personal interviews with industry leaders, the percentages of various product forms and packaging procedures currently used, along with expectations for the future, were identified for the representative plants.

For objective 2, catfish processing plants similar in size to the representative plants identified in objective 1 were synthesized using the economic-engineering approach. Each phase (or stage) of the processing cycle was identified, and costs for each of the phases were determined. When alternative technology existed for performing functions at each stage, the most efficient was used. Appropriate equipment prices were obtained from processors and suppliers. Installation charges and building needs were estimated through contractors and industry personnel. Labor data were obtained from processors' input-output records, from engineering and/or time and motion studies and from manufacturers' specifications. After determining the least-cost method for accomplishing each phase, or each function within a phase, the phases were aggregated into an efficient overall processing plan.

To accomplish objective 3, annual ownership and operating costs for plants of each size were determined using data obtained in objective The total cost of processing w evaluated for each of the plant si to determine if economies of s exist in the catfish processi industry.

In order to discover if econom of size exist in the catfish processi industry, it is first necessary discover cost of processing catfi for alternative plant sizes or p cessing capacities. To determi this, the data obtained must consistent with maximum physic and economic efficiency in order estimate the least-cost combinatio for chosen plant sizes [2]. Therefo the economic-engineering approac supplemented with a survey of exi ing plants, was chosen to estima the cost components of processi catfish in plants of different size

The Economic - Engineering Approach

Alternative technologies exist for performing different phases of catfish processing, and evaluating the cost variation for each of these options is vital. In order to have overall efficiency in the operation, the least-cost method must be determined for each phase of processing. The determined input-output coefficients and cost estimates for each phase then can be aggregated into a minimum total cost function for the catfish processing facility [2].

The economic-engineering approach is well suited for this type of analysis. It allows the production process to be divided into specific phases so that the most efficient technology can be selected for each phase. The most efficient techniques for each of the phases can then be merged into an efficient working firm. The economic-engineering approach is particularly relevant in analyzing industries that exhibit wide variations in firm size, technology utilization, level of management employed and degree of excess capacity. These characteristics generally identify an "infant" industry where the economic-engineering approach may be the only applicable methodology to measure efficiency [2,9].

There are two major advantages of this approach. First, the most efficient technology can be used for each phase of processing as opposed to adopted technology. This offers a more realistic approach to assessing what can actually be achieved. Second, because cost estimates are formulated through a "building block" approach, the effects of price changes for selected inputs can be examined easily [2].

Some criticism of the economic-engineering approach is aimed at the derivation of cost estimates. Some of the costs involved with a particular technique may be overlooked. Problems also may occur in keeping the technology within feasible bounds. For example, performance rates quoted by man facturers may be in excess of wh is actually attainable in t industry. Verification of these rat by processors is certainly mand tory in order to provide sound co estimates. This means that go judgment coupled with the "chec ing out" of cost and performan rates is necessary to provide val cost estimates. An additional cri cism is that of time. This involv how to deal with time in regard resource flows and rewards ov time with imperfect knowledg risk and uncertainty [2, 3].

These weaknesses exist in t economic-engineering approach, b it may be the only feasible way determine the costs for this n and unique industry. It is believ that this approach, coupled wi careful and rigorous scrutiny of elements of the processing facili provides sound estimates of cost

Model Plants and Product Mix

Four plant sizes (models) were selected for analysis. Daily one-shift capacities of the plants were 32,000, 64,000, 96,000 and 160,000 pounds live-weight, for Models I, II, III and IV, respectively. Plant sizes were determined primarily on the basis of performance rates of the most efficient technology presently available for heading and eviscerating catfish. The most efficient technologies for other supporting phases of processing were based on capacities consistent with the heading and eviscerating equipment selected.

The particular product mix that a catfish processing plant produces is important in determining that plant's processing cost. For instance, a plant that processes a high percentage of fillets obviously has a higher processing cost per unit of output than does a plant that processes a high percentage of whole fish. This is true because the actual processing cost per pound live-weight is higher for fillets, and a lower yield of saleable product is obtained. The product mix chosen for this study was based on industry averages, adjusted to reflect trends.

The actual product mixes were obtained from personal interviews with management representatives of cooperating plants. Also, leaders in the processing industry expressed their opinions as to what product-mix changes seem to be forthcoming in the industry. Based on this information, a product mix believed to be representative of what the industry will be producing over the next few years was designated for this study. This mix (in terms of output) consisted of about 60% whole fish, 35% fillets and 5% steaks. To achieve this output mix, live fish entering the plant must be allocated to the three product forms approximately as follows: 50% to whole fish, 45% to fillets and 5% to steaks. It was further assumed that 50% of each category in the mix is processed for sale in the fresh market, and 50% is allocated to the frozen market. Of the 50% in fresh form, one half is processed as ice-packed fish, and one half is in tray pack (chilled) form. This product mix is illustrated in Figure 1.

Dressing percentage or yield obtained when processing live fish

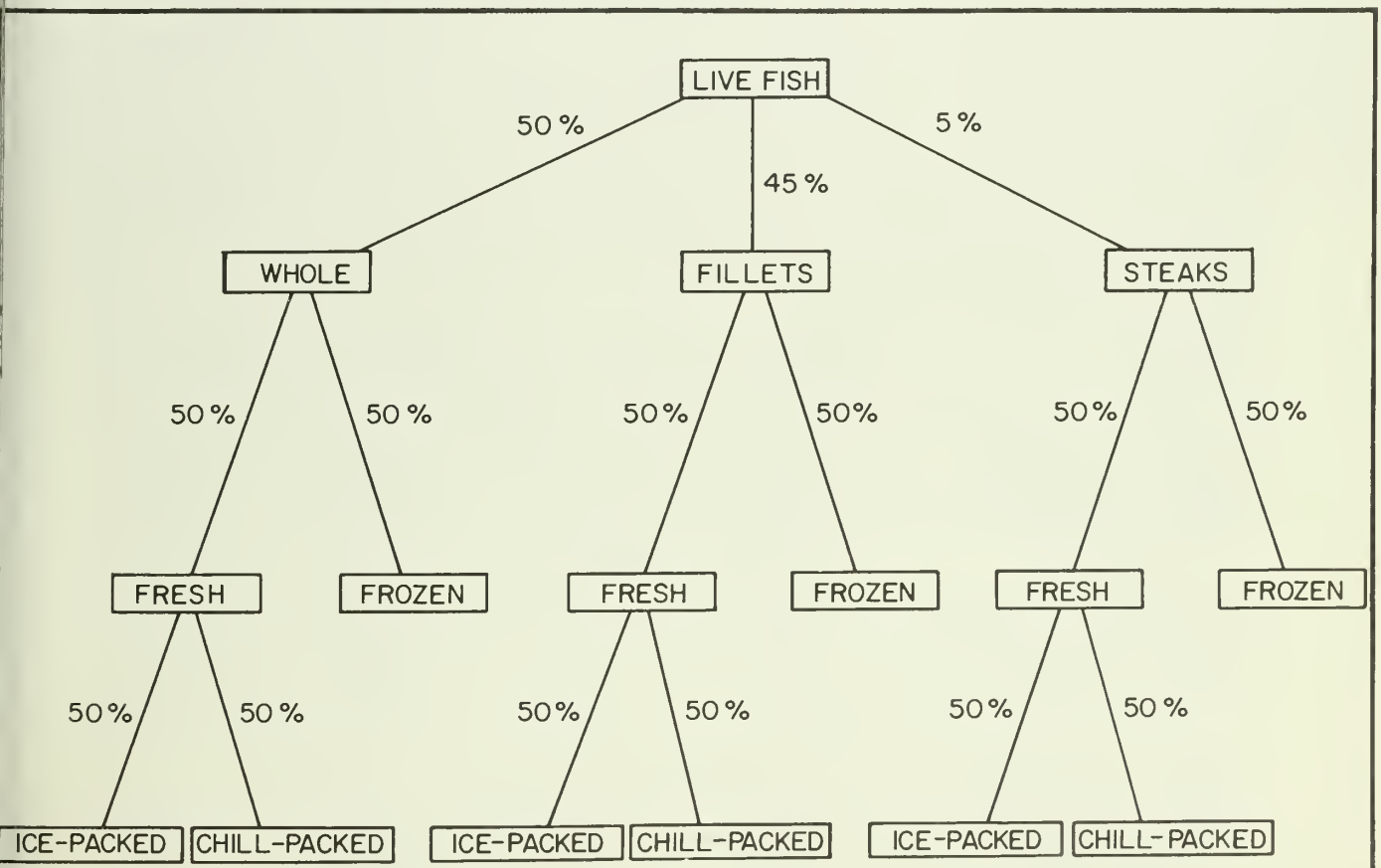

FIGURE I. ILLUSTRATED PRODUCT MIX FOR THE MODEL CATFISH PROCESSING PLANTS.

into various product forms varies among existing plants. For instance, the dressing percentage for whole fish has ranged from 59 to as high as 62. This range is largely explained by variations in size of fish processed and by whether the dorsal fin is removed. As the size of fish increases, dressing percentages increase. Also, some plants elect to remove the dorsal fin, and some do not.

The yield of whole fillets generally varies from 38 to 42% of live weight. Again, the size of fish plays a major role in this variation. Fillets are processed into two individual forms ---whole or shank. Shank fillets are whole fillets with belly flap ("nugget") removed. The yield of shank fillets ranges from 80 to 89% of the whole fillet, the remainder being nuggets. These variations arise from the method of filleting and/or the amount of nugget left on the shank fillet. In essence, some plants sell more of the fillet as a nugget than do others.

For the purposes of this stud was assumed that the average s of a catfish for processing was 1 pounds. Based on this assumpt the dressing percentages used the various product forms w whole fish 60%, whole fillets 4 and steaks 55%. The annual dres weight distributions for the f model plants, based on the giv product mix and the assumed dre ing percentages, are presented Table 1.

Plant Facilities

Real Estate

Selection of a plant site is critical, and making this decision requires careful consideration. The foremost consideration should be proximity to the cafish farms. Other factors include (1) site accessibility, including convenient connections with highway systems and railroad lines; (2) size, shape and cost of the site, including preparation and development; (3) availability and cost of utilities at the site; (4) industrial zoning status of the site, existing easements and other legal considerations; (5) availability of suitable labor; (6) availability of fire protection and police security and (7) annual taxes and insurance rates for the site.

All model plants were assumed to be in the Delta of Mississippi. Plants were assumed to be located on a paved road where three-phase el tricity and a water system capa of supplying 500 gallons per minu were available. Availability of municipal sewage system was n assumed; thus, cost of a was treatment system adequate for tre ment and discharge of plant efflue was included in the study. La meeting these requirements has estimated average value of $2,0

Table 1. Annual dressed weight distribution of product mix for four model catfish processing plants, Delta area of Mississippi, 1983

Product Form	Plant Size			
	Model I	Model II	Model III	Model IV
	thousands of pounds			
Whole (ice pack)	576.0	1,152.0	1,728.0	2,880.0
Whole (tray pack)	576.0	1,152.0	1,728.0	2,880.0
Whole (frozen)	1,152.0	2,304.0	3,456.0	5,760.0
Total whole	2,304.0	4,608.0	6,912.0	11,520.0
Fillets (ice pack)	345.6	691.2	1,036.8	1,728.0
Fillets (tray pack)	345.6	691.2	1,036.8	1,728.0
fillets (frozen)	691.2	1,382.4	2,073.6	3,456.0
Total fillets	1,382.4	2,764.8	4,147.2	6,912.0
Steaks (ice pack)				
Steaks (tray pack)	52.8	105.6	158.4	264.0
Steaks (frozen)	52.8	105.6	158.4	264.0
Total steaks	105.6	211.2	316.8	528.0
Total	3,897.6	7,795.2	11,692.8	19,488.0

r acre. Land requirements and sts are presented in Table 2. Land requirements were based n requirements for buildings, a ceiving and holding area for live tfish, parking, loading and area r the waste-water treatment faci-y. Additional area also was allow-l for each plant around the waste-ater lagoon to satisfy state law quirement of a 300 foot buffer ne on all sides of the waste-treat-ent facility.

Waste-Treatment Facility

The method of effluent disposal used by a catfish processing plant depends largely upon the facility location and the accessibility of a municipal sewage system. Alternatives include (1) use of an existing system capable of handling the needs of the plant and pretreating effluent before discharge; (2) locating this facility in the country, with treatment and discharge into an existing drainageway and (3) locating the facility in the country and treating and storing the effluent for irrigation purposes. Methods (2) and (3) necessitate primary and secondary treatment of effluent before discharge or use for irrigation.

For the purposes of this study, the second method was chosen because (1) there are apparent

Table 2. Estimated land requirements and costs for four model catfish processing plants, Delta area of Mississippi, 1983

Facility Area	Unit	Plant Size			
		Model I	Model II	Model III	Model IV
Receiving[a/]	sq. ft.	3,680	4,960	6,240	8,800
Building[b/]	sq. ft.	15,004	22,212	28,850	42,005
Waste treatment[c/]	sq. ft.	558,000	729,189	818,389	981,504
Parking and loading[d/]	sq. ft.	20,250	32,940	45,630	65,070
Miscellaneous[e/]	sq. ft.	42,445	55,353	62,240	74,450
Total land	sq. ft.	639,376	844,654	961,349	1,171,829
	(Acres)	(14.68)	(19.39)	(22.07)	(26.90)
Total cost	dollars	29,356	38,781	44,139	53,803

a/ Includes holding vats and live haul area.

b/ Includes eviscerating and processing rooms, refrigeration, offices, break room, and storage.

c/ Includes area for buffer zone.

d/ Based on two employees per parking space.

e/ Includes area between plant and waste treatment facility as well as an area for landscaping.

advantages to locating outside municipalities and (2) the economic feasibility of using the effluent for irrigation in the Delta has not been investigated.

The level of effluent treatment necessary to meet federal regulations is dependent upon the flow of the drainageway into which the effluent is discharged. The greater and more consistent the flow of water in the drainageway, the less stringent are the regulations regarding the levels of effluents. For this study, it was assumed that there was year-round flow and that plants would be located on drainageways where flows are adequate.

Size of waste-treatment facilities needed varies according to the daily processing capacities of the plants. Costs of the waste-treatment facilities necessary for the four model plants are presented in Appendix Tables 1-4. Costs include construction, a pump station, engineering fees and permits required for construction, but do not include cost of land.

Building Requirements

Capital outlays necessary for modern catfish processing plants are mainly for buildings, processing equipment and trucks. Building costs are dependent upon several factors, such as the topography of the land and the type of building constructed.

For this analysis, it was assumed that the plants would be constructed on relatively level land. The general construction of the building w assumed to be of metal wi masonry interior walls. Cost es mates reflect varying concrete sl depths as necessary depending up the freezer-cooler space in a par cular plant.

Building layouts, in general, we synthesized on the basis of th equipment requirements for pr cessing the given product mix. Floo space requirements were based o the square footage needed for th specified equipment, as well as wall ways and workspace requirement in each general area of the pr cessing facility. Average construc tion costs of $45 per square foo were used for all the model plants Space requirements for specifi plant area and construction cost are presented in Table 3.

Table 3. Estimated building requirements and costs for four model catfish processing plants, Delta area of Mississippi, 1983

Facility Area	Unit	Plant Size			
		Model I	Model II	Model III	Model IV
Receiving	sq. ft.	3,680	4,960	6,240	8,800
Eviscerating room	sq. ft.	2,025	2,925	3,825	5,700
Processing room	sq. ft.	4,050	5,850	7,650	11,400
Office	sq. ft.	5,306	6,557	7,330	8,409
Refrigeration	sq. ft.	1,880	3,762	5,642	9,406
Offal and equipment	sq. ft.	743	1,073	1,403	2,090
Miscellaneous	sq. ft.	1,000	2,000	3,000	5,000
Total	sq. ft.	18,684	27,172	35,090	50,805
Unit cost	$/sq. ft.[a]	45	45	45	45
Total cost	dollars	840,780	1,222,740	1,579,050	2,286,225

[a] Includes costs for building, mechanical, electrical, boilers, driveways and parking lot. Does not include any costs for refrigeration or processing equipment.

[2] *This rate was provided by a major building-construction firm that has been involved in constructing catfish processing plants in the area.*

Receiving

The receiving area is for unloading catfish from live-haul trucks into holding vats, where the fish are kept alive until processed. Holding vats were assumed to be 45 feet long by 4 feet wide, sloping from 3 feet deep at one end to 4 feet deep at the other. This allows ease of exit from the holding vat as fish are essentially water flumed into a waiting receiving basket. Each vat can hold about 4000 pounds of live catfish.

It was assumed that each plant has a catfish holding capacity equal to one-half of its daily processing capacity. This ensures a processing supply when delays are incurred in procuring fish. The receiving-area space requirements for each plant are presented in Table 3.

Parking and Loading

Space requirements for parking, loading-out processed fish and driveways were estimated on the basis of the number of employees and the size of the plant. Parking space was calculated on the basis of a requirement of 270 square feet per car. It was assumed that employees travel to work in groups of two, on the average. Space requirements for driveways and loading areas were based on the number of trucks at the dock, turnaround and parking requirements and the drive area. This area was about the same as employee parking in each instance. Space requirements for the parking and loading areas for each model plant are presented in Table 2.

Equipment Requirements

All equipment needed to process the given product mix adequately was considered for each model plant. The equipment needs of the respective plants were grouped into general categories, or phases, in the order that they occur in the processing cycle. These include (1) receiving, (2) heading and eviscerating, (3) skinning, (4) chilling, (5) sorting, (6) filleting, (7) ice packing, (8) tray packing, (9) steaking, (10) individual quick freezing, (11) refrigeration, (12) offal disposal and (13) welfare and offices. In many instances, alternative technology is available for individual phases of the processing cycle. A cost comparison of alternative technology was used as a basis for determining the most efficient equipment available for each phase of processing.[3] The text that follows discusses alternative technologies available for given phases and the technology chosen for inclusion in the study. Equipment requirements and associated costs are presented in Appendix Tables 1-4.

Receiving

The equipment requirements for the receiving area include an overhead track system with a track scale for weighing catfish. A steel track is attached to the metal trusses of the building, and an electrical hoist and trolley maneuver baskets of fish along this track. The hoist and trolley should have a capacity of about 10,000 pounds. Receiving baskets, which usually are made of stainless steel mesh with a drop bottom, also are needed to hold the fish during movement through the receiving area.

When the receiving baskets of fish reach the entrance to the eviscerating room, a holding structure and an electrical shock system are needed. The catfish are transferred from the receiving baskets into the holding structure and are then conveyed through an electrical shock system to immobilize them.

Heading and Eviscerating

Head removal generally can be done by one of two methods---a handfed meat type bandsaw or an automated system. The bandsaw line, more commonly referred to as a headsaw line, is highly labor intensive, requiring more than twice the labor of an automated line. However, the capacity of the headsaw line is greater than that of the automated line.

The annual ownership and operating costs of the two systems are very close. A comparison indicated that the headsaw line is slightly more cost efficient under the production, wage and interest rates used. The eviscerating machine, which

[3] *Detailed cost analyses are contained in Fuller, Marty J., "Cost-Size Relationships in the Processing of Farm-Raised Catfish in the Delta Area of Mississippi," Unpublished Ph.D. Dissertation, Department of Agricultural Economics, Mississippi State University, May 1984.*

removes the entrails, sometimes creates a bottleneck in the automated line and slows production; whereas, conventional evisceration methods have no apparent problems. If the eviscerating machine could be modified to keep up with the header of the automated system, it undoubtedly would be the more efficient of the two technologies.

Based on the cost comparisons of the two systems and the present problem with the automated eviscerating machine, the headsaw line was chosen for use in this study. The equipment requirements for this particular line include (1) a distribution conveyor, (2) two layup tables, (3) two headsaws, (4) a belly-split table, (5) a six-station vacuum eviscerating system, (6) a two-tier conveyor and (7) a stainless steel belt conveyor. A schematic of the two-headsaw line is shown in Figure 2.

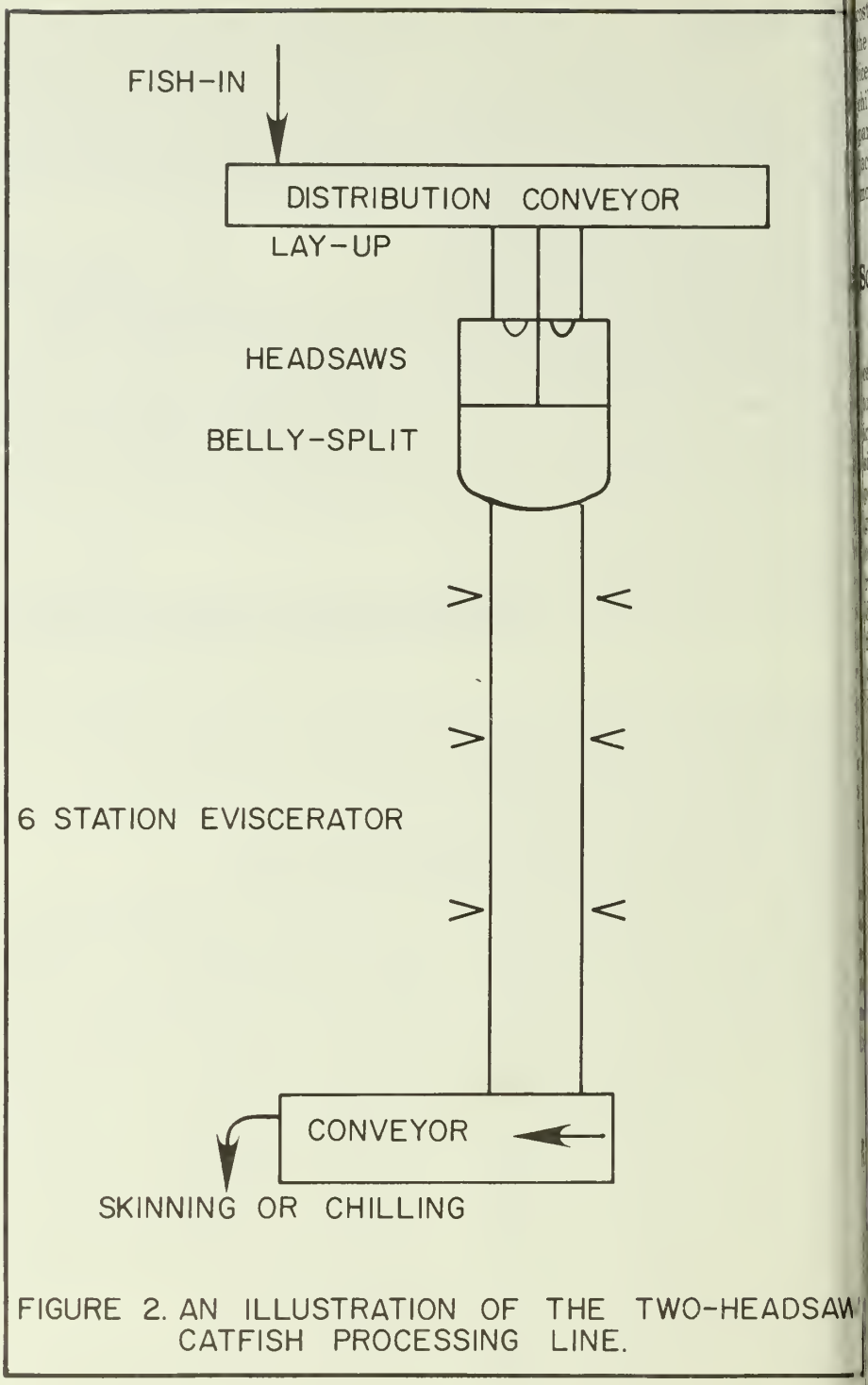

FIGURE 2. AN ILLUSTRATION OF THE TWO-HEADSAW CATFISH PROCESSING LINE.

Skinning

Skinning of whole catfish is accomplished by a mechanical skinner. The fish are passed by hand over a rotary drum and knife mechanism and the skin is pulled from the fish. Machines in use at present were developed for skinning other products and have been adapted for skinning catfish. Skinning costs used in this study were based on the predominant skinning machine used in the industry. Automated equipment is available for skinning fillets, but not whole catfish.

Chilling

The chilling phase of the processing cycle involves reducing the temperature of the beheaded, eviscerated and skinned fish to a temperature of 39° to 40°F. Alternatives available for chilling include ice-bath chillers and refrigerated jacketed chillers. In both instances, the fish are conveyed and dropped into the entrance end of the chiller, are moved by a network of paddles to the other end and are conveyed out of the chiller.

The ice-bath chiller is basically a large stainless steel tub that contains water and requires ice to kee the water cold. The jacketed chill requires ice only at start-up an refrigeration cools the water for th remainder of the processing da The trade-off between the tw systems is relatively high initi

ost of the jacketed system against
ne relatively high operating cost
ce requirements) of the ice-bath
iller. Based on a total cost com-
arison of the two systems, the
cketed chiller was chosen for the
odel plants.

orting

Individual sorting allows the pro-
essor to divert fish of different size
the proper processing areas. For
stance, the smaller to medium-
ze fish usually go to whole fish
rocessing while the larger fish
enerally are processed as steaks
r fillets. Further sorting usually is
quired after the fish reach a
esignated processing area. Most
arm-raised catfish product forms
re packaged in two-ounce incre-
ents, and it is important that
ese packaging increments be accu-
ate. Thus, individual weighing of
ne various product forms is requir-
d.

Hand sizing and automated sizing
re the two main alternatives avail-
le to the processor. A cost compari-
n indicated that an automatic
stem supplemented with hand
zing would be more cost-effective
the model plants.

illeting

Filleting of catfish can be done
y hand or by automated equipment.
Hand filleting is highly labor inten-
ive while automatic filleting is
ighly capital intensive. Factors
ther than the labor-capital trade-
ff between automated and hand
illeting are involved in comparing
he two approaches. First, based on
mited data, it appears that the
ercentage yield of shank fillet
iffers by method. Second, a true
ugget is obtained from hand fillet-
ng while the automatic equipment
oes not produce a nugget per se.
The meat left on the frame is wasted unless it is separated from the frame and sold in minced form. Therefore, the selling prices of shank fillets, nuggets and possible minced product enter into the comparison of the two methods.

A cost and returns comparison based on the limited data available revealed that hand filleting is slightly more cost-effective than is the automatic equipment under the assumed production, wage and interest rates used in the study. However, small changes in wages, performance rates, dressing percentage of shank fillets, interest rates or any combination of the above may alter the economics of hand versus machine filleting.

Steaking

Catfish are cut into steaks by a bandsaw. The operator feeds the fish along a guide that is set according to desired thickness and the steaks are channeled to the proper packing area.

Automatic steaking machines are available, but the standard bandsaw was used for purposes of this study. The quantity of steaks produced with the product mix used for this study was not sufficient to justify the automatic equipment for any of the model plants.

Ice Packing

Ice packing of catfish is a relatively straightforward procedure. Ice is conveyed by an auger from the ice room to suspended ice drops that deposit pre-measured amounts of ice into ice-pack boxes. After fish are placed into the boxes and covered with ice, the boxes are topped, strapped and conveyed to a holding cooler.

The necessary equipment includes a screw auger, ice drops and an ice machine. The auger and drops are included in the building construction.

Tray Packing

Most tray packing is done by machine. A liner is placed in the bottom, and the fish are placed in the tray. It is then conveyed into a machine that wraps and seals a plastic film around the product. The tray-packed fish then can pass through a pricing machine where it is weighed and priced according to pricing information that can be preprogrammed into the machine. Comparisons of two major brands of tray-packing systems revealed little difference in costs.

Individual Quick Freezing

Catfish are quick frozen, as a general rule, by carbon dioxide (CO_2). The CO_2 is used to freeze the individual pieces of fish quickly to retain product quality. Other methods, such as liquid nitrogen and mechanical freezing, are available, but their costs were not determined because of limited data.

The individual pieces of catfish are placed on a conveyor that runs through a CO_2 tunnel or spiral freezer. A dwell time of about 10-20 minutes can reduce the core temperature of the fish to about -40°F. The fish are conveyed out of the tunnel or spiral into a water-glaze bath that protects and preserves the frozen fish. The frozen products are then boxed and sent to the freezer as expeditiously as is possible.

Differences in efficiencies of spiral and tunnel freezers were noted by some industry personnel. Some believed that the CO_2 cost/lb was lower for the spiral freezer than for the tunnel freezer. A cost comparison based on data obtained from manufacturers of both tunnels and spirals suggests the spiral CO_2 freezer is more efficient.

Refrigeration

Refrigeration systems required in

modern catfish processing plants are among the more costly equipment items. The refrigeration area is composed of a cooler, a freezer and a blast freezer. The cooler, which is maintained at 28°F, is used primarily for ice-packed and chill-packed products. The freezer, maintained at about 0°F, is for the frozen product forms. The blast freezer has special functions, such as timed use for crust freezing of chill-packed product and, in some instances, an intermediate stop for frozen products. The size of the system necessary for each model plant was based on a holding capacity of two weeks inventory.

Refrigeration alternatives considered were the conventional freon system and an ammonia-type system. The ammonia system has an initial cost about twice that of the freon system but has a longer expected life and, on large systems, operates more efficiently. Nevertheless, the freon-type system was selected here because the model plants do not require refrigeration systems sufficiently large to justify the ammonia system.

Offal

As a general rule existing processing plants do not render their offal. Offal is generally conveyed from the eviscerating and processing rooms into holding tanks and transported to an off-site rendering plant. Also, the waste water is usually put through a strainer system to recover solids from the water. This reduces costs of transportation and rendering, as well as the load placed on the lagoon. Therefore, a straining system was incorporated in the model plants of the study.

Welfare and Offices

Office equipment requirements were based on the number of office personnel and the respective needs of each. The welfare area needs were based on federal inspection guidelines which require facilities such as lockers and toilets. An employee break/lunch room was included for each plant. The size and components of this room, such as tables and chairs, were estimated based on the number of employees in the respective plants.

Investment Requirements and Costs

Estimated investment requirements pertain only to the given product mix used in this study. Variations in the product mix may change the equipment and/or facility make-up and in turn alter the investment requirements. Furthermore, the total investment estimates (Table 4) do not include investment in harvesting and hauling equipment for live fish and distribution equipment (trucks) for processed products.

Building costs represent a major portion of the total investment, ranging from 52 to more than 54% of the total (Table 5). Processing room equipment comprises the second major cost item, ranging from 18 to more than 20% of total investment. Investment in the remaining necessary items varied from less than 1 to slightly more than 7% of the total.

Table 4. Estimated investment requirements for four model catfish processing plants, Delta area of Mississippi, 1983

Item	Plant Size			
	Model I	Model II	Model III	Model IV
	dollars			
Land	29,356	38,781	44,139	53,803
Waste treatment facility	80,000	110,000	160,000	200,000
Buildings	840,780	1,222,740	1,579,050	2,286,225
Receiving equipment	16,780	19,780	22,780	35,560
Eviscerating room	89,308	139,020	187,732	302,776
Processing room	323,101	448,239	537,982	854,604
Refrigeration	61,032	96,172	120,578	179,236
Material handling	21,605	22,085	39,840	61,925
Cleanup	11,935	13,870	15,805	27,740
Furniture	25,350	36,421	45,120	53,064
Miscellaneous equipment	67,851	88,460	110,876	175,896
Waste handling	31,625	32,300	47,300	62,050
Total	1,598,723	2,267,868	2,911,202	4,292,879

Table 5. Estimated investment requirements expressed as a percentage of total investment for four model catfish processing plants, Delta area of Mississippi, 1983

Item	Plant Size			
	Model I	Model II	Model III	Model IV
	percent			
Land	1.84	1.71	1.52	1.25
Waste treatment facility	5.00	4.85	5.50	4.66
Buildings	52.59	53.92	54.24	53.26
Receiving equipment	1.05	.87	.78	.83
Eviscerating room	5.59	6.13	6.45	7.05
Processing room	20.21	19.76	18.48	19.91
Refrigeration	3.82	4.24	4.14	4.18
Material handling	1.35	.97	1.37	1.43
Cleanup	.75	.61	.54	.65
Furniture	1.59	1.61	1.55	1.24
Miscellaneous equipment	4.24	3.90	3.81	4.10
Waste handling	1.98	1.42	1.62	1.45
Totals[1/]	100.0	100.0	100.0	100.0

[1/] May not add due to rounding.

Ownership Costs

Ownership costs (fixed costs) of urable assets occur even if the ssets are not used. These costs clude depreciation, interest, taxes nd insurance. Procedures employ- l in calculating the annual owner- ip cost estimates (Table 6) for the ur model plants are as follow:

Depreciation

Depreciation was calculated by the straight-line method based on estimated useful life of each piece of equipment (Appendix Tables 1-4). A zero salvage value was assumed for all buildings, facilities and equipment because little is known about salvage values of much of the equipment used in catfish processing.

Interest

Interest at a rate of 12% was charged on one half of the original investment in depreciable items such as buildings and equipment. Non-depreciable items, such as land and lagoons, were charged at an interest rate of 11.5% on the full inventory value.

Table 6. Estimated annual costs for four model catfish processing plants, Delta area of Mississippi, 1983

Item	Plant Size			
	Model I	Model II	Model III	Model IV
	dollars			
Annual Ownership Costs				
Depreciation	99,523	140,705	182,298	280,315
Insurance	28,000	44,289	61,992	108,247
Interest	101,940	143,654	185,902	271,186
Taxes	10,761	15,265	19,595	28,895
Sub-Total	240,224	343,913	449,787	688,643
Annual Operating Costs				
Personnel				
Wages	604,043	967,325	1,429,260	2,152,977
Salaried	467,112	779,052	990,570	1,255,360
Utilities				
Electricity	35,050	54,224	66,879	107,145
Water	3,756	9,132	14,508	25,260
Telephone	41,143	54,857	62,286	96,000
Repairs and Maintenance	41,680	59,004	74,457	118,199
Supplies and Services				
CO_2	77,986	155,971	233,957	389,928
Packaging	202,560	405,120	607,680	1,012,800
Misc. Supplies & Services[a]	21,060	36,120	51,182	81,302
General Office Overhead	28,696	47,120	64,607	93,226
Sub-Total	1,523,086	2,567,925	3,615,386	5,332,197
Interest on Operating Capital	65,151	125,519	185,914	302,922
Total Annual Operating Costs	1,588,237	2,693,444	3,801,300	5,635,119
Total Costs	$1,828,461	$3,037,357	$ 4,251,087	$ 6,323,762
Cost per Pound[b]	.4691	.3896	.3636	.3245

[a] Includes private laboratory fees, chemicals, fillet knives, uniforms, assorted tools and supplies for maintenance, and bathroom supplies.

[b] Based on pounds processed annually (dressed weight) from Table 1.

Insurance

Insurance coverage for each of the model plants includes fire, vandalism and malicious mischief and extended coverage. Extended coverage includes hail, windstorm, smoke, riot or civil commotion and explosion. A base rate of $1.60 per $100 of buildings and equipment was used for a plant of 7500 square feet. An excess area charge amounting to 2 1/2 cents per 1000 square feet was used to calculate the additional rate per $100 of buildings and equipment for the four model plants.

Taxes

Property taxes are considered rt of annual ownership costs, d an average rate applicable to e Delta area of Mississippi was ed. The standard assessment is sed on the appraised value of nd, buildings, equipment and the erage inventory on January 1 of ch year. The appraised value was sumed to be original cost, and the erage inventory was assumed to two weeks production at capacity. e value of the inventory was timated as 15% of the appraised lue of land, buildings and equipent. The average tax rate used to termine annual taxes incurred the model plants was 58.53 mills.

perating Costs

Operating costs (variable costs) clude labor, utilities, repairs and aintenance and necessary pplies such as CO_2 gas, boxes, ays, film, general office overhead nd interest on operating capital able 6).

Personnel

Labor requirements for the four odel plants were estimated on the asis of each plant's level of output, anufacturers' specifications, engieering studies, personal interviews ith plant personnel and, in some ases, time-motion studies of partilar phases of processing. The ourly employee requirements for ach model plant are presented by hase of operation in Appendix able 5.

The average wage rate used for rocessing labor was $3.71 per hour. Vage rates for maintenance and ecurity personnel were set at $5.00 er hour. These rates are representave of wages paid in 1983 in Mississippi catfish processing plants. Vage rates were increased by 15% o cover fringe benefits for the ourly employees.

Numbers of salaried personnel and salary levels were estimated using data obtained from personal interviews with managers of existing processing plants. Salaried personnel requirements for each model plant are presented in Appendix Table 6. A rate of 20% was used for fringe benefits for salaried personnel. Appendix Table 7 shows salary costs by position.

Utilities

Electricity Requirements and Costs---Electricity is used in catfish processing primarily for lighting and for operating electric motors. Survey of existing processors revealed that the refrigeration equipment consumed about one-fourth of the total electricity required. Once the electrical consumption for refrigeration equipment was determined, the consumption was quadrupled to reflect the needs of the entire plant.

Electricity requirements for refrigeration in the model plants were calculated on the basis of the horsepower necessary to run the equipment. Efficiency of motors of different sizes used was obtained from engineering studies. The cost of electricity was estimated for the respective model plants by applying the November 1983 Mississippi Power and Light Company rates for the Delta area of Mississippi to the estimates of consumption.

Water Requirements and Costs---Large amounts of water are needed by catfish processing plants. Water is needed for holding vats, processing equipment, clean-up, ice making and for use by plant personnel. Consumption requirements for the model plants were based on actual use by existing plants. Water consumption by the industry averages 2 gallons of water per liveweight pound of fish.

The cost of water consumed by each of the model plants was determined by applying the 1983 average water rates existing in the study area to the estimates of consumption. Rates used were $215 for the first one million gallons plus $.35 per 1,000 gallons in excess of one million gallons.

Telephone Service and Costs---Monthly service and equipment charges for each of the model plants were estimated according to the number of salaried personnel and the number of lines, intercoms and related equipment for each model plant. Long distance billing was based on the industry average prevailing at the time of the study.

Repairs and Maintenance

Annual repairs and maintenance for the four model plants were computed from estimates of average repairs over the life of the component as a percentage of the estimated purchase price. Estimated life and repair and maintenance costs were obtained from manufacturers' specifications, dealer estimates and estimates from processing plant personnel.

Supplies and Services

The total cost of CO_2 used to quick-freeze individual pieces of catfish in each plant was based on a cost of 3.85 cents per pound of frozen fish. Packaging supplies for processed catfish vary according to product forms. The major items include boxes for ice-packed, individually quick-frozen and chill-packed products and trays, pads, film, stickers and tape. Costs of packaging supplies were estimated to be 5 cents per pound of processed fish (average of all product forms). Office supplies and general overhead were estimated as slightly less than 2% of annual operating cost.

The major items in miscellaneous supplies and services are chemicals for the tri-phosphate injector, clean-

ing systems and chlorination of water. Also included in the estimate is a charge for private laboratory services. The amount and cost of injection solutions were obtained from dealers. Fees for private laboratory work were obtained from processing plant personnel.

Interest on Operating Capital

Interest on operating capital was based on an annual rate of 12%. It was assumed that the operating capital necessary for the plant was one-twelfth of total annual operating cost plus the cost of live catfish F.O.B. processing plant for one month. A price of 65 cents per pound live-weight was assumed as the purchase price.

Total Costs

Ownership costs ranged from 10.58% of total cost in Model III to 13.14% of total cost in Model I (Tab 7). Depreciation and interest wer the major ownership cost items an ranged from almost 9 to slightl more than 11% of total annual cos

Annual operating cost was abou 88% of total cost. Personnel cos ranged from slightly more tha 53% to slightly more than 58% c total cost. No other operating cos accounted for more than 16.02% c total cost, and most other item accounted for less than 5% of tota cost.

Table 7. Estimated annual cost components expressed as a percentage of total costs for four model catfish processing plants, Delta area of Mississippi, 1983

Item	Plant Size			
	Model I	Model II	Model III	Model IV
	percent			
Annual Ownership Costs				
Depreciation	5.44	4.63	4.29	4.43
Insurance	1.53	1.46	1.46	1.71
Interest	5.58	4.73	4.37	4.29
Taxes	.59	.50	.46	.46
Sub-Total	13.14	11.32	10.58	10.89
Annual Operating Costs				
Personnel				
Wages	33.04	31.85	33.62	34.05
Salaried	25.55	25.65	23.30	19.85
Utilities				
Electricity	1.92	1.79	1.57	1.69
Water	.21	.30	.34	.40
Telephone	2.25	1.81	1.94	1.52
Repairs and Maintenance	2.28	1.94	1.75	1.87
Supplies and Services				
CO_2	4.27	5.14	5.50	6.17
Packaging	11.08	13.34	14.29	16.02
Miscellaneous Supplies	1.15	1.19	1.20	1.29
General Office Overhead	1.57	1.55	1.52	1.47
Interest on Operating Capital	3.56	4.13	4.37	4.79
Sub-Total	86.86	88.68	89.42	89.11
Total[1/]	100.0	100.0	100.0	100.0

[1/] May not add due to rounding.

Annual total costs were 1,828,461, $3,037,357, $4,251,087 nd $6,323,762 for Models I, II, III, nd IV, respectively (Table 6). Cost er pound of processing catfish were 4691, $.3896, $.3636 and $.3245 for ie respective models, evincing sub-antial decreases in per-unit costs s plant size increased.

More than one half of the operat-ig cost for each model plant was r wages and salaries. Labor and alary costs per pound decreased as plant size increased. Wages and salaries totaled more than 27 cents per pound in Model I and decreased to 22.4, 20.7 and 17.5 cents per pound in successive models (Table 8). Much of this decrease is explained by the fact that numbers of management and supervisory personnel do not increase in proportion to increases in size of plant.

The estimated total, ownership and operating costs per pound reveal substantial economies of size in processing farm-raised catfish (Figure 3).

Effects of Varying Wage Rates

To determine the effects of higher wages on total annual costs of processing for each of the model plants, the effective hourly wage rate was increased from $3.71 to $4.96 in increments of 25 cents. Fringe benefits for each of the wage rates were

Table 8. Estimated annual cost components expressed in cents per pound for four model catfish processing plants, Delta area of Mississippi, 1983

Item	Plant Size			
	Model I	Model II	Model III	Model IV
	cents			
Annual Ownership Costs				
Depreciation	2.55	1.80	1.56	1.44
Insurance	.72	.57	.53	.55
Interest	2.62	1.84	1.59	1.39
Taxes	.28	.19	.17	.15
Sub-total	6.16	4.41	3.85	3.53
Annual Operating Costs				
Personnel				
Wages	15.50	12.41	12.22	11.05
Salaried	11.99	9.99	8.47	6.44
Utilities				
Electricity	.90	.70	.57	.53
Water	.10	.12	.12	.13
Telephone	1.06	.71	.71	.49
Repairs and Maintenance	1.07	.76	.64	.61
Supplies and Services				
CO_2	2.00	2.00	2.00	2.00
Packaging	5.20	5.20	5.20	5.20
Miscellaneous Supplies	.54	.46	.44	.42
General Office Overhead	.74	.60	.55	.48
Interest on Operating Capital	1.67	1.61	1.59	1.55
Sub-Total	40.75	34.55	32.51	28.92
Total[1/]	46.91	38.96	36.36	32.45

[1/] May not add due to rounding.

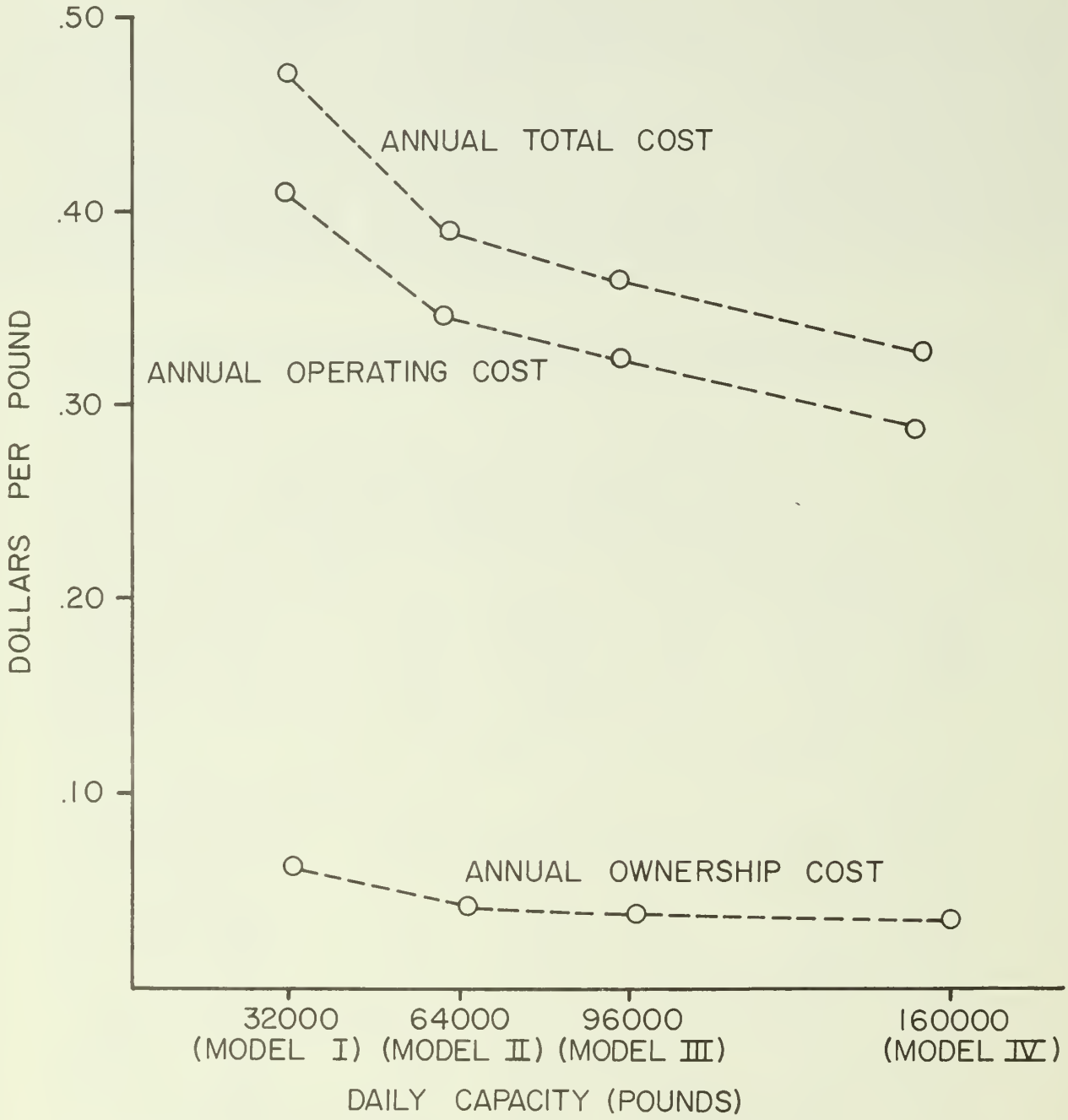

FIGURE 3. TOTAL, OPERATING AND OWNERSHIP COSTS PER POUND OF PROCESSING CATFISH, BY SIZE OF PLANT.

sumed to be 15%. Generally, with ces of other inputs held constant, ch 25 cent increase in the wage e increased total cost from .74 to 4 cents per pound, depending on nt size (Table 9). This may not appear dramatic in this context, but, when viewed from the total annual cost basis, the effects are more readily observable. For instance, a 1 cent cost increase per pound results in increases in total cost, ranging from $38,976 for Model I to $194,880 for Model IV. Thus, a small variation in the wage rate has a significant impact on total cost of processing.

Table 9. Estimated total cost per pound of processing catfish at selected wage rates, four model catfish processing plants, Delta area of Mississippi, 1983

Wage Rate	Plant Size			
	Model I	Model II	Model III	Model IV
	dollars			
$3.71	.4691	.3896	.3636	.3245
3.96	.4795	.3980	.3718	.3319
4.21	.4899	.4064	.3800	.3393
4.46	.5003	.4148	.3882	.3467
4.71	.5107	.4232	.3964	.3541
$4.96	.5211	.4316	.4046	.3615

Summary, Conclusions and Limitations

An economic-engineering proach was used to estimate instment requirements and costs of ocessing catfish in the Delta of ssissippi. Performance rates of e most efficient technologies avail- le for heading and eviscerating erations were used to synthesize ants with daily processing capa- ies of 32,000, 64,000, 96,000 and 0,000 pounds of catfish (live- eight). For the analysis, the plants re designated Models I-IV.

The product mix, derived from dustry averages adjusted for ex- cted near-future change, was 60% hole fish, 35% fillets and 5% steaks. he half of each product volume was to be processed as fresh fish, the remainder as frozen. The fresh fish were divided equally between ice-packed and chill-packed (tray-packed). Data for selecting the most efficient method and equipment for each processing operation were obtained from processors' records, manufacturers' specifications, dealer estimates and in some instances, time and motion studies.

Estimated investment requirements at 1983 prices ranged from $1.6 million for the least of the four plants to about $4.3 million for the largest. In each instance, building cost amounted to slightly more than one half of the total investment requirement, and equipping the eviscerating and processing room amounted to another one fourth.

Estimates of total annual costs in the four synthesized establishments ranged from $1.8 million to $6.3 million. Estimates of ownership costs (depreciation, interest on investment, taxes and insurance) ranged from $240,224 to $688,643. Annual operating cost estimates ranged from about $1.6 million to $5.6 million and accounted, on average, for about 88% of total annual costs.

At these costs and processing volumes, processing costs per pound (unit costs) were 46.91¢ in Model I

(the least-volume plant); 38.96¢ in Model II; 36¢ in Model III and 32.45¢ in Model IV (the largest plant). Ownership costs (fixed costs) declined sharply---from 6.16¢ to 3.53¢---as plant size (volume) increased. Operating costs per pound decreased from 40.75¢ in Model I to 28.92¢ in Model IV, indicating major economies in size of processing in larger plants.

A drop in salary and labor costs from 27.49¢ to 17.49¢ per pound of processing fish over the range of plant sizes indicates increases in efficiency in the use of both salaried personnel and laborers. Even small increases in labor efficiency have significant impact on unit costs because cost of hourly labor comprise 31-34% of total costs. Conversely, small increases in wage rates can increase unit costs appreciably. Indications are that a 25 cent increase in wage rates, other things being equal, would result in processing cost increases ranging from .74¢ in the largest plant to 1.04¢ per pound in the smallest.

The largest plant studied achieved the most economies of size, and it is possible that even larger plants may have lower costs. For example, some processing technologies, such as automated steaking and ammonia refrigeration systems, were not included in the model plants because of insufficient volume to justify these technologies. Also, it is likely that per-unit cost reductions associated with marketing and distribution of product from larger plants will more than offset additional per-unit procurement costs as plant size increases.

Costs of livehauling fish to the plant and distribution costs of the processed product were not included in the study. Also, some marketing costs, such as advertising and brokerage, were not included. More research is needed to determine cost-size relationships associated with procurement and marketing and distribution of farm-raised catfish.

The lack of data relating to some alternative equipment items caused the omission of these items from cost comparisons with their counterparts. Alternative technology exists for a particular phase of processing in some instances, but adequate data could not be obtained. Therefore, change to a more efficient piece of equipment for a given phase could slightly alter the cost of processing figures derived in this study.

Additionally, when comparing alternative technologies for a given phase, dressing percentages and product prices in some instan
played a major role in the determi
tion of the most efficient technolo
Slight changes in dressing p
centage, relative product pric
interest rate and wage rate c
modify the equipment make-
formulated for the plants in t
study. In turn, the cost of processi
coefficients would be altered, a
the cost-size relationships dicuss
in this study possibly may be affe
ed.

The model catfish processi
plants are highly labor intensive.
wage rates should increase relati
to interest rates, more automati
would be included in the processi
plants, and in turn, the cost
processing estimates would
altered. It is likely that the e
nomies outlined in this study cou
be affected by this relative chang

Cost estimates derived in th
study are consistent with the und
lying assumptions made and m
not reflect actual cost of any o
plant existing in the study are
For example, at the time of th
study, some plants were not oper
ing at one-shift capacity and m
have costs higher than those repo
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Appendix Tables

Table 1. Estimated land, building and equipment requirements, initial investment, expected life and associated annual costs, Model Plant I, Delta area of Mississippi, 1983

Item	Quantity	Estimated New Cost	Expected Life	Annual Repairs	Annual Interest	Annual Depreciation
		($)	(Years)	($)	($)	($)
Land	Lot	29,356	--	--	3,376	--
Waste treatment facility	Lot	80,000	--	--	9,200	--
Buildings	Lot	840,780	25	8,408	50,447	33,631
Receiving area						
Shock system	1	4,000	5	200	240	800
Basket holding structure	1	4,000	20	--	240	200
Haul baskets	2	6,000	20	--	360	300
Overhead track scales	1	2,780	5	139	167	556
Eviscerating room						
Layup tables	2	1,200	15	--	72	80
Belly split tables	1	600	15	--	36	40
Headsaw	3	6,912	6	1,152	414	1,152
Vacuum eviscerator	1	9,000	6	675	540	1,500
Freon chiller	1	33,200	10	1,328	1,992	3,320
Automatic skinner	4	29,000	5	4,352	1,740	5,800
Two tier conveyor	1	4,116	5	412	247	823
Transfer conveyor	1	2,000	3	200	120	667
Elevating conveyor	1	3,280	5	230	197	656
Processing room						
Automatic sorter	1	62,555	10	1,251	3,753	6,256
Roller conveyor	1	1,260	15	--	76	84
Sort/pack tables	4	4,000	15	--	240	268
Electronic scales	4	10,056	5	504	604	2,012
Fillet table	1	17,000	8	850	1,020	2,125
Tray pack system	1	29,480	5	2,948	1,769	5,896
CO_2 freezer	1	108,350	15	4,334	6,501	7,223
CO_2 tank	1	30,000	15	--	1,800	2,000
Tri-phosphate injector	1	42,500	15	5,950	2,550	2,833
Box taping system	1	4,400	10	110	264	440
Ice machine	1	13,500	10	675	810	1,350
Material handling						
Fork truck	1	17,275	15	864	1,037	1,152
Walkie	1	3,850	15	385	231	257
Floor pallet mover	1	480	15	48	29	32
Clean-up						
Foam cleaning system	1	1,935	10	48	116	194
High pressure washdown	1	10,000	10	500	600	1,000
Office furniture & equip.	Lot	25,350	1/	--	1,521	2,768
Waste handling						
Offal tank	1	13,750	20	--	825	688
Offal strainer	1	7,875	10	788	473	788
Offal lift conveyor	1	10,000	15	500	600	667
Refrigeration	Lot	61,032	10	3,052	3,662	6,103
Miscellaneous	Lot	67,851	2/	1,777	4,071	5,708
Totals		1,598,723	--	41,680	101,940	99,523

1/ Office chairs have an expected life of 5 years. All other office furniture and equipment was assumed to have a 15 year life.

2/ Depending on function, expected life of miscellaneous equipment ranges from 10 to 15 years.

Table 2. Estimated land, building and equipment requirements, initial investment, expected life and associated annual costs, Model Plant II, Delta area of Mississippi, 1983

Item	Quantity	Estimated New Cost	Expected Life	Annual Repairs	Annual Interest	Annual Depreciation
		($)	(Years)	($)	($)	($)
Land	Lot	38,781	--	--	4,460	--
Waste treatment facility	Lot	110,000	--	--	12,650	--
Buildings	Lot	1,222,740	25	12,227	73,364	48,910
Receiving area						
Shock system	1	4,000	5	200	240	800
Basket holding structure	1	4,000	20	--	240	200
Haul baskets	3	9,000	20	--	540	450
Overhead track scales	1	2,780	5	139	167	556
Eviscerating room						
Distribution conveyor	1	2,000	3	200	120	667
Layup tables	4	2,400	15	--	144	160
Belly split tables	2	1,200	15	--	72	80
Headsaw	6	13,824	6	2,304	828	2,304
Vacuum eviscerator	2	18,000	6	1,350	1,080	3,000
Freon chiller	1	33,200	10	1,328	1,992	3,320
Automatic skinner	8	58,000	5	8,704	3,480	11,600
Two-tier conveyor	1	4,116	5	412	247	823
Transfer conveyor	1	3,000	5	300	180	600
Elevating conveyor	1	3,280	5	230	197	656
Processing room						
Automatic sorter	1	62,555	10	1,251	3,753	6,256
Roller conveyor	1	2,520	15	--	152	168
Sort/pack tables	6	6,000	15	--	360	402
Electronic scales	6	15,084	5	756	906	3,018
Fillet table	1	49,000	8	1,730	2,340	4,875
Tray pack system	1	29,480	5	2,948	1,769	5,896
CO_2 freezer	1	189,200	15	7,568	11,352	12,613
CO_2 tank	1	30,000	15	--	1,800	2,000
Box taping system	1	4,400	10	110	264	440
Tri-phosphate injector	1	42,500	15	5,950	2,550	2,833
Ice machine	1	17,500	10	875	1,050	1,750
Material handling						
Fork truck	1	17,275	15	864	1,037	1,152
Walkie	1	3,850	15	385	231	257
Floor pallet mover	2	960	15	96	58	64
Clean-up						
Foam cleaning system	2	3,870	10	96	232	388
High pressure washdown	1	10,000	10	500	600	1,000
Waste handling						
Offal strainer	1	8,550	10	855	513	855
Offal tank	1	13,750	20	--	825	688
Offal lift conveyor	1	10,000	15	500	600	667
Office furniture & equip.	Lot	36,421	1/	--	2,185	3,977
Refrigeration	Lot	96,172	10	4,809	5,770	9,617
Miscellaneous	Lot	88,460	2/	2,317	5,307	7,442
Totals		2,267,868	--	59,004	143,654	140,705

1/ Office chairs have an expected life of 5 years. All other office furniture and equipment was assumed to have a 15 year life.

2/ Depending on function, expected life of miscellaneous equipment ranges from 10 to 15 years.

Table 3. Estimated land, building and equipment requirements, initial investment, expected life and associated annual costs, Model Plant III, Delta area of Mississippi, 1983

Item	Quantity	Estimated New Cost	Expected Life	Annual Repairs	Annual Interest	Annual Depreciation
		($)	(Years)	($)	($)	($)
Land	Lot	44,139	--	--	5,076	--
Waste treatment facility	Lot	160,000	--	--	18,400	--
Buildings	Lot	1,579,050	25	15,791	94,743	63,162
Receiving area						
Shock system	1	4,000	5	200	240	800
Basket holding structure	1	4,000	20	--	240	200
Haul baskets	4	12,000	20	--	720	600
Overhead track scales	1	2,780	5	139	167	556
Eviscerating room						
Distribution conveyor	1	3,000	3	300	180	1,000
Layup tables	6	3,600	15	--	216	240
Belly split tables	3	1,800	15	--	108	120
Headsaw	9	20,736	6	3,456	1,242	3,456
Vacuum eviscerator	3	27,000	6	2,025	1,620	4,500
Freon chiller	1	33,200	10	1,328	1,992	3,320
Automatic skinner	12	87,000	5	13,056	5,220	17,400
Two-tier conveyor	1	4,116	5	412	247	823
Transfer conveyor	1	4,000	5	400	240	800
Elevating conveyor	1	3,280	5	230	197	656
Processing room						
Automatic sorter	2	125,110	10	2,502	7,506	12,512
Roller conveyor	1	3,780	15	--	228	252
Sort/pack tables	8	8,000	15	--	480	536
Electronic scales	8	20,112	5	1,008	1,208	4,0[illegible]
Fillet table	2	44,000	8	1,760	2,640	5,500
Tray pack system	1	29,480	5	2,948	1,769	5,896
CO_2 freezer	1	189,200	15	7,568	11,352	12,613
CO_2 tank	1	30,000	15	--	1,800	2,000
Tri-phosphate injector	1	42,500	15	5,950	2,550	2,833
Ice machine	1	37,000	10	1,850	2,220	3,700
Box taping system	2	8,800	10	220	528	880
Material handling						
Fork truck	2	34,550	15	1,728	2,074	2,304
Walkie	1	3,850	15	385	231	257
Pallet mover	3	1,440	15	144	87	96
Clean-up						
Foam cleaning system	3	5,805	10	144	348	582
High pressure washdown	1	10,000	10	500	600	1,000
Waste handling						
Offal strainer	1	9,800	10	980	588	980
Offal holding tank	2	27,500	20	--	1,650	1,376
Offal lift conveyor	1	10,000	15	500	600	667
Office furniture & equip.	Lot	45,120	1/	--	2,707	5,271
Refrigeration		120,578	10	6,029	7,235	12,058
Miscellaneous	Lot	110,876	2/	2,904	6,653	9,328
Totals		2,911,202	--	74,457	185,902	182,298

1/ Office chairs have an expected life of 5 years. All other office furniture and equipment was assumed to have a 15 year life.

2/ Depending on function, expected life of miscellaneous equipment ranges from 10 to 15 years.

Table 4. Estimated land, building and equipment requirements, initial investment, expected life and associated annual costs, Model Plant IV, Delta area of Mississippi, 1983

Item	Quantity	Estimated New Cost	Expected Life	Annual Repairs	Annual Interest	Annual Depreciation
		($)	(Years)	($)	($)	($)
Land	Lot	53,803	--	--	6,187	--
Waste treatment facility	Lot	200,000	--	--	23,000	--
Buildings	Lot	2,286,225	25	22,862	137,174	91,449
Receiving area						
Shock system	2	8,000	5	400	480	1,600
Basket holding structure	1	4,000	20	--	240	200
Haul baskets	6	18,000	20	--	1,080	900
Overhead track scales	2	5,560	5	278	334	1,112
Eviscerating room						
Distribution conveyor	1	4,000	3	400	240	1,333
Layup tables	10	6,000	15	--	360	400
Belly split tables	5	3,000	15	--	180	200
Headsaws	15	34,560	6	5,760	2,074	5,760
Vacuum eviscerator	5	45,000	6	3,375	2,700	7,500
Two-tier conveyor	1	4,116	5	412	247	823
Freon jacketed chiller	1	52,500	10	2,100	3,150	5,250
Automatic skinners	20	145,000	5	21,760	8,700	29,000
Transfer conveyor	1	5,320	5	532	319	1,064
Elevating conveyor	1	3,280	5	230	197	656
Processing room						
Automatic sorter	4	250,220	10	5,004	15,013	25,022
Roller conveyor	1	5,670	15	--	340	378
Sort/pack tables	11	11,000	15	--	660	733
Electronic scales	11	27,654	5	1,386	1,659	5,531
Fillet table	3	83,000	8	3,490	4,980	10,375
Tray pack system	2	58,960	5	5,896	3,538	11,792
CO_2 freezer	1	235,400	15	9,416	14,124	15,693
CO_2 tank	1	30,000	15	--	1,800	2,000
Box taping system	3	13,200	10	330	792	1,320
Ice machine (20 ton)	1	37,000	10	1,850	2,220	3,700
Ice machine (10 ton)	1	17,500	10	875	1,050	1,750
Tri-phosphate injector	2	85,000	15	11,900	5,100	5,666
Material handling						
Fork truck	3	51,825	15	2,592	3,111	3,456
Walkie	2	7,700	15	770	462	513
Floor pallet mover	5	2,400	15	240	144	160
Clean-up						
Foam cleaning system	4	7,740	10	192	116	128
High pressure washdown	2	20,000	10	1,000	1,200	2,000
Waste handling						
Offal strainer	1	10,800	10	1,080	648	1,080
Offal holding tank	3	41,250	20	--	2,475	2,064
Offal lift conveyor	1	10,000	15	500	600	667
Office furniture & equip.	Lot	53,064	1/	--	3,184	6,317
Refrigeration	Lot	179,236	10	8,962	10,754	17,924
Miscellaneous	Lot	175,896	2/	4,607	10,554	14,798
Totals		4,292,879	--	118,199	271,186	280,315

1/ Office chairs have an expected life of 5 years. All other office furniture and equipment was assumed to have a 15 year life.

2/ Depending on function, expected life of miscellaneous equipment ranges from 10 to 15 years.

Table 5. Hourly labor requirements by phase of operation for four model processing plants, Delta area of Mississippi, 1983

Equipment	Plant Size			
	Model I	Model II	Model III	Model IV
	Quantity			
Receiving	2	2	3	4
Eviscerating room				
Headers	2	4	6	8
Layup	2	4	6	8
Belly split	3	6	9	12
Conveyor operator	--	1	1	1
Eviscerators	5	10	15	20
Skinners	6	12	18	30
Inspect/wash	1	2	3	5
Sub-total	21	41	61	88
Processing room				
Icore loaders	2	2	3	7
Hand sort	--	1	--	--
Icore pan handlers	3	3	6	11
Filleters	13	26	39	65
Fillet pan handlers	1	2	3	5
Icers	2	2	4	6
Ice packers/boxers	2	3	5	7
Box strapper	1	1	2	2
Fillet sorters	2	3	4	6
Steakers	1	1	1	2
Pan handler	1	1	1	2
Tray packers/boxers	4	6	8	12
Sub-total	32	51	76	125
IQF belt loaders	2	3	4	6
Sorters	2	2	3	5
Boxers	2	3	4	6
Strappers	1	1	1	2
Cooler/freezer	1	1	2	2
Pallet handler	2	3	4	7
Sub-total	10	13	18	28
Clean-up	4	5	6	7
Maintenance	2	3	4	5
Security guards	3	3	6	6
Sub-total	9	11	16	18
Total hourly labor	72	116	171	259

Table 6. Estimated salaried personnel requirements for four model plants, Delta area of Mississippi, 1983

Equipment	Model Plant			
	Model I[a]	Model II	Model III	Model IV
	Quantity			
President	--	1	1	1
Marketing director	1	1	1	1
Comptroller	--	1	1	1
Distribution manager	1	1	1	1
Plant manager	1	1	1	1
Production superintendent	4	6	7	9
Bookkeeper	1	1	2	2
Secretary	3	5	6	7
Personnel manager	--	1	1	1
Quality control	1	1	1	2
Salesman	2	3	4	5
Customer service	1	1	2	2
Federal inspector[b]	1	1	1	1
Total salaried personnel requirements	15	23	28	33

[a] In Model Plant I, the duties of more than one position may be assigned to an employee. For example, an employee may serve as president and marketing director of the model plant.

[b] The federal inspector is paid on a half-time basis. This position is not included in the calculation of total salaried personnel requirements.

Table 7. Estimated salary costs by position for four model processing plants, Delta area of Mississippi, 1983

Position	Plant Size			
	Model I[a]	Model II	Model III	Model IV
	dollars			
President	61,200	67,320	74,052	81,457
Marketing director	61,200	67,320	74,052	81,457
Comptroller	46,200	50,820	55,902	61,492
Distribution manager	46,200	50,820	55,902	61,492
Plant manager	39,600	43,560	47,916	52,708
Production supervisor	26,400	29,040	31,944	35,138
Bookkeeper	19,800	19,800	19,800	19,800
Secretary	12,000	12,000	12,000	12,000
Personnel manager	33,000	36,300	39,930	43,923
Quality control	39,600	43,560	47,916	52,708
Salesman	33,000	36,300	39,930	43,923
Customer service	33,000	36,300	39,930	43,923
Federal inspector[b]	20,112	20,112	20,112	20,112

[a] Includes fringe benefits.

[b] Half-time.

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The Influence of Binary Seed Mixtures of 'Stoneville 825' and 'Deltapine 41' Cotton Varieties on Their Performance

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The Influence of Binary Seed Mixtures of 'Stoneville 825' and 'Deltapine 41' Cotton Varieties on Their Performance

The production of genetically pure seed by farmers has been encouraged by many agricultural organizations. Some of the most important agencies that promote pure seed through certification are the crop improvement associations. The purpose of seed certification is to maintain and make available to the public high-quality seed of superior plant varieties that are grown and distributed to maintain high-quality genetic identity and purity. Classes of seed that meet certain standards of the crop improvement association are generally designated as Breeder, Foundation, Registered or Certified. Inspection and standards for specific crops are based on the description of the variety as set forth by the breeder, and variants and "off-types" cannot exceed specific crop standards. An "off-type" usually refers to plants that deviate in one or more characteristics from the variety described. All associations must meet minimum AOSCA standards; however, quality standards may vary greatly from state to state.

It has been noted that some cottonseed arriving in Mississippi from other states, particularly the West, occasionally produce high percentages of "off-type" plants. These "off-type" plants are generally plants of other cotton varieties that resulted from mixtures that probably occurred during ginning. Some states allow more than one variety to be grown on a farm and more than one variety to be ginned at the same gin. These factors along with possible failure to adequately inspect harvesting equipment and gins lead to occasional mixtures of varieties. To minimize seed mixtures in Mississippi-grown cottonseed, the Mississippi Seed Improvement Association does a good job of assuring that fields are in compliance with isolation standards and that fields, gins, harvesting equipment and storage facilities are properly inspected. Certification is a guarantee that varietal purity has been maintained and the varieties' characteristics can be depended upon.

The objective of this study was to determine the influence of seed mixtures of cotton varieties on performance.

Materials and Methods

Seed of 'Deltapine 41' and 'Stoneville 825' used in this study had about the same germination percentage, 92 and 91%, respectively. Deltapine 41 had about 800 more seed per pound than did Stoneville 825 (5,316 and 4,503 seed per pound, respectively), and the seed were counted to ensure the same seeding rate. The plots consisted of two rows 59 feet long with 40 inches between rows. The seeding rate was 350 acid-delinted seed on each row (700 seed per plot). This study was conducted over a two-year period (1981-82), and a randomized complete block design with four replications was used each year. Planting dates were April 21 in 1981 and April 27 in 1982 on a Bosket sandy loam at Stoneville, Mississippi.

Eleven treatments (seed samples) were included in this study. The eleven treatments consisted of two pure seed lots (100% Deltapine 41 and 100% Stoneville 825) and nine seed mixtures of the two varieties. The mixed seed lots consisted of 90, 80, 70, 60, 50, 40, 30, 20 and 10% Stoneville 825, and the remaining percentage of each mixture was Deltapine 41. These two varieties were chosen because they represent nectaried (Deltapine 41) and nectariless (Stoneville 825) varieties that had shown about the same yield potential. Deltapine 41 possesses smaller seed, higher lint percentage, stronger fiber and a lower micronaire value than does Stoneville 825.

Yield determinations were based on the weight of cotton harvested from two-row plots. Determinations of lint percentage, boll size and fiber properties were made from hand-picked samples from two replications each year. Fiber property evaluations were made in the Cotton Fiber Lab at Stoneville.

Results

The percentage of seedlings that emerged ranged from 71.7 to 75.4%. There were no significant differences in seedling emergence among the eleven treatments, thus plant populations were about the same (Table 1).

The two-year average (1981-82) lint yields of the eleven treatments ranged from 876 to 963 pounds per acre, but these differences were not statistically significant. Average lint yield of the two pure-seed lots was 935 pounds. Average yield of the 50%:50% mixtures (912 pounds of lint) was less than that of the pure-seed lot, and this implies that the varieties may be antagonistic to each other (Figure 1). These two varieties have about the same yield potential, and the data indicate that mixing seed of two high-yielding varieties that are recommended for planting would not significantly influence lint yield. A treatment-by-year interaction was not detected in this study.

Lint percentage ranged from 38.75 to 41.60, with Deltapine 41 having a 2.8% higher lint percentage than did Stoneville 825. Significant differences in lint percentage were obtained and tended to increase as the

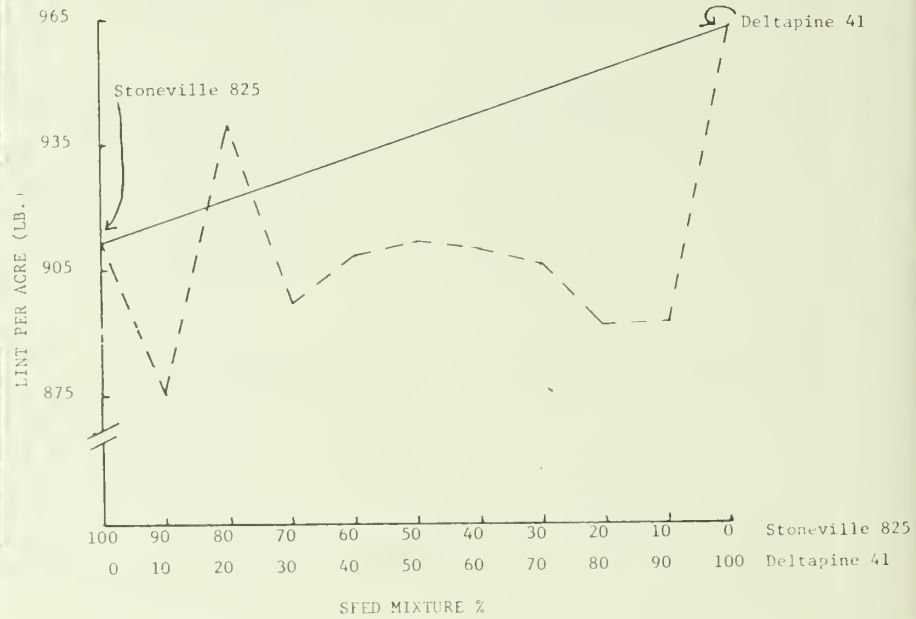

Figure 1. Influence of seed mixtures on lint yield.

Table 1. The influence of seed mixtures of cotton on performance, 1981-82 average.

Seed Mixture %	LINT PER ACRE Total	Lint percent	Boll size grams	FIBER PROPERTIES Length 2.5%	Length 50%	Strength g/tex	Elongation	Micronaire	% Seedling emergence
100% Stoneville 825	907	38.80	5.05	1.09	.51	18.62	6.8	4.8	73.4
*90% Stoneville 825	876	38.75	4.98	1.09	.50	18.87	7.3	4.8	72.9
80% Stoneville 825	939	38.80	5.00	1.09	.52	18.74	8.2	4.5	71.7
70% Stoneville 825	897	39.25	5.01	1.09	.50	18.79	7.7	4.7	73.1
60% Stoneville 825	908	39.55	5.02	1.10	.51	19.09	7.8	4.7	72.5
50% Stoneville 825	912	39.32	5.00	1.09	.50	20.34	8.6	4.6	73.2
40% Stoneville 825	910	39.45	5.03	1.11	.52	19.43	7.3	4.8	73.0
30% Stoneville 825	906	40.35	4.82	1.09	.51	19.51	8.2	4.6	75.4
20% Stoneville 825	892	40.60	4.89	1.10	.51	19.55	8.0	4.6	73.6
10% Stoneville 825	893	41.05	4.79	1.09	.51	20.02	8.4	4.5	74.5
100% Deltapine 41	963	41.60	4.81	1.10	.51	20.24	8.4	4.5	74.7
LSD .05	NS	.71	.20	NS	NS	0.65	0.8	0.1	NS
C.V. in %	12.2	1.1	2.5	1.8	--	3.0	4.2	2.0	4.6

Planted: April 21, 1981 and April 27, 1982
Harvested: September 21, 1981 and September 30, 1982
Irrigated: July 16, 1981 and July 13, 1982

*90% Stoneville 825 and 10% Deltapine 41

proportion of Deltapine 41 seed in the mixture was increased. Again, the varieties were antagonistic in their action rather than synergistic (Figure 2).

Bolls of Deltapine 41 were significantly smaller than those of Stoneville 825, and there was a slight tendency for bolls to decrease in size as the proportion of Deltapine 41 seed in the mixture was increased. The 50:50 mixtures produced a larger boll size than did one of the pure lots (Deltapine 41), suggesting that synergistic effects were becoming evident for this characteristic (Figure 3).

No significant trends were noted for fiber length, which was expected because the two varieties possess about the same fiber length. Deltapine 41 produced significantly stronger fiber than did Stoneville 825 (20.24 vs. 18.62 g/tex), with the two pure lots of each variety having the strongest and weakest fiber, respectively. The general trend was for fiber strength to increase as the proportion of Deltapine 41 was increased.

Fiber elongation values ranged from 6.8 to 8.6, and Deltapine 41 possessed a significantly higher elongation value than did Stoneville 825. Elongation values of fiber from the seed mixtures were generally between the values of the two pure lines, with no specific trend evident.

The 50:50 mixture produced higher responses than did either of the varieties for fiber strength and elongation, suggesting that synergistic effects were coming into play for these characters (Figures 4 and 5).

Micronaire values ranged from 4.5 to 4.8, and significant differences were detected. As the percentage of Stoneville 825 in the mixtures increased, the micronaire values tended to increase. The 50:50 mixture produced a larger micronaire than did one of the pure seed lots (Deltapine 41) and a micronaire value equal to that of Stoneville 825,

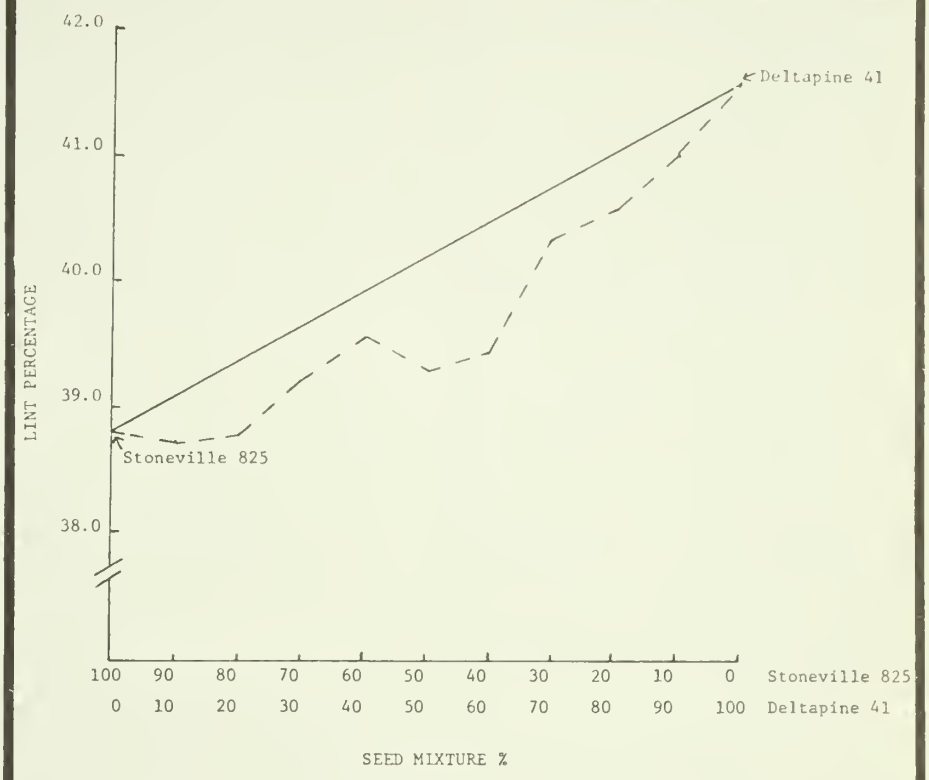

Figure 2. Influence of seed mixtures on lint percentage.

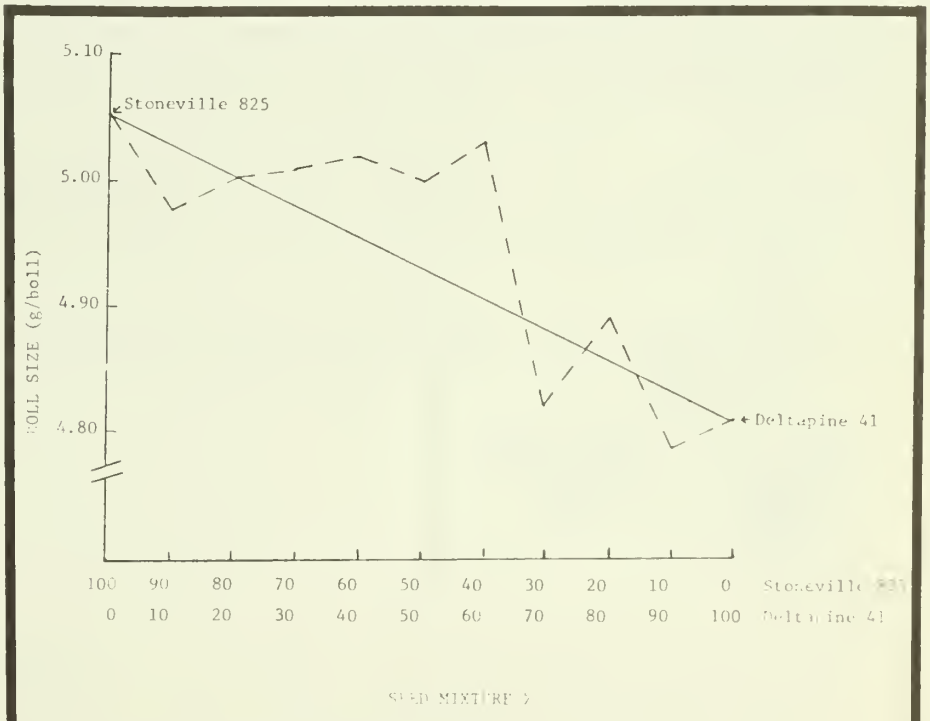

Figure 3. Influence of seed mixtures on boll size.

suggesting that synergistic effects were becoming evident for micronaire (Figure 6).

These two varieties were selected for this study because of their popularity and varietal characteristics. Stoneville 825 is a nectariless variety with larger bolls, larger seed, weaker fiber, higher micronaire value and a lower lint percentage as compared to Deltapine 41. This study indicates that mixing seed of two adapted high-yielding varieties had no significant influence on yield. The data do suggest, however, that lint percentage, boll size and fiber properties are influenced by seed mixtures. The data also suggest that the varieties may be antagonistic to each other for lint yield and lint percentage, and synergistic to each other for boll size and fiber properties.

If certification procedures are neglected and basically pure seed lots are not obtained, varietal identification will become virtually impossible. Our results indicate that seed mixtures may cause changes in fiber quality and it is conjectured that seed mixtures could influence yield if varieties with different yielding capacities are mixed.

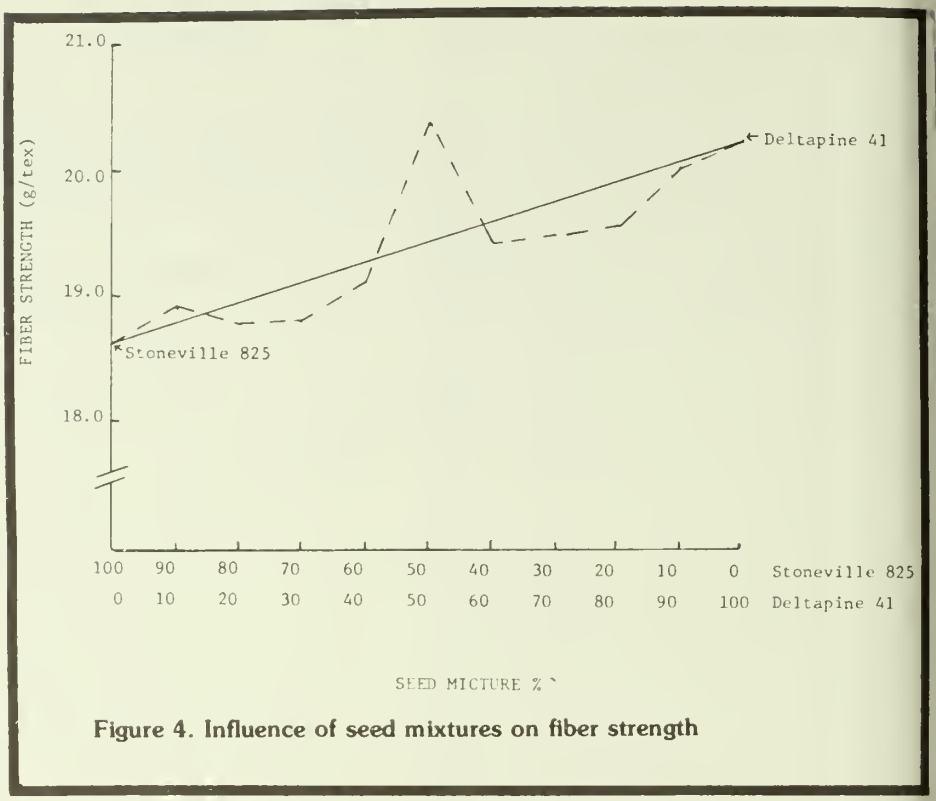

Figure 4. Influence of seed mixtures on fiber strength

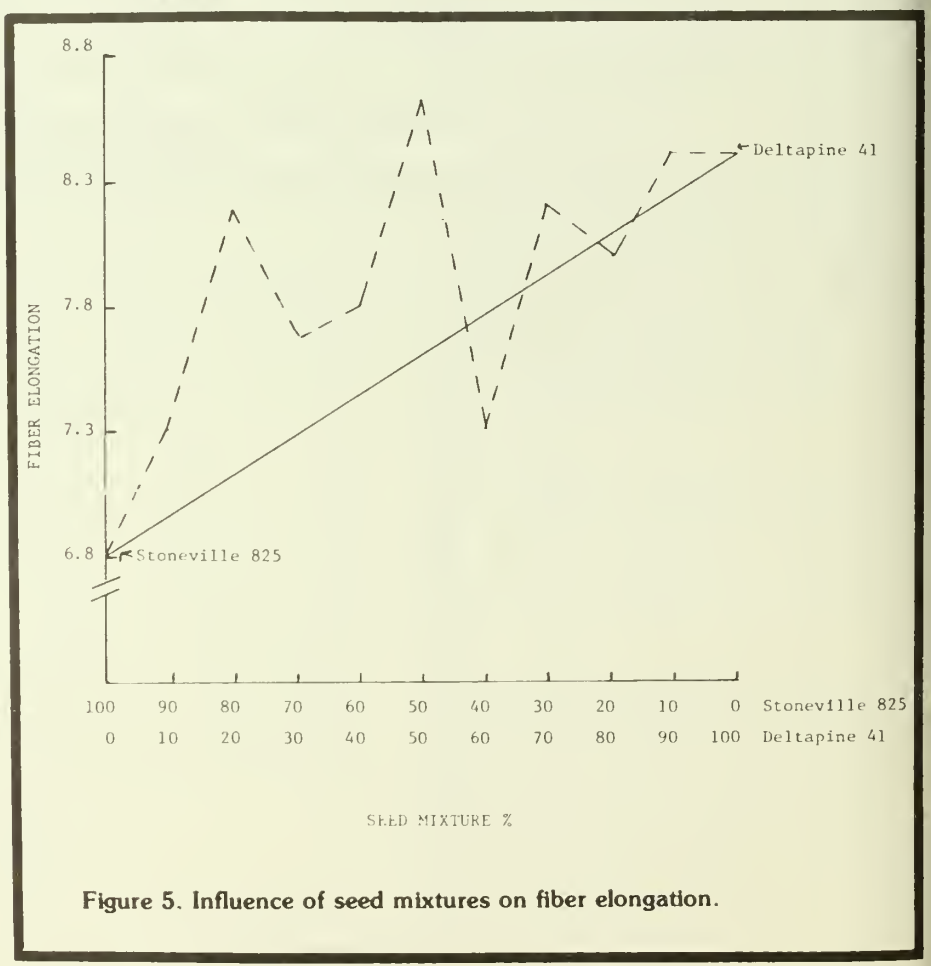

Figure 5. Influence of seed mixtures on fiber elongation.

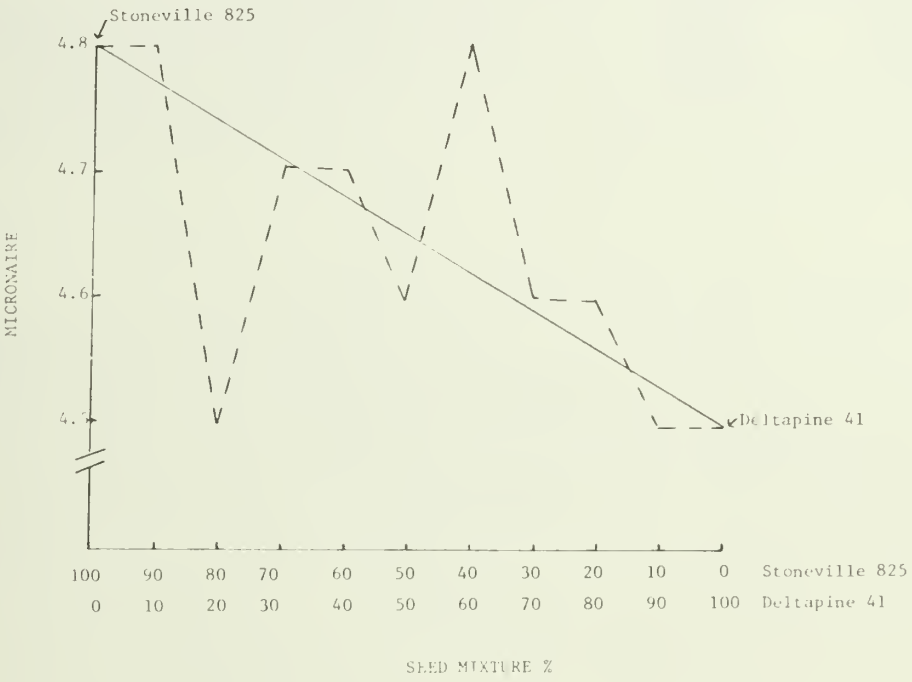

Figure 6. Influence of seed mixtures on micronaire.

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SLOSS (Soil Loss) An Interactive Model for Microcomputers

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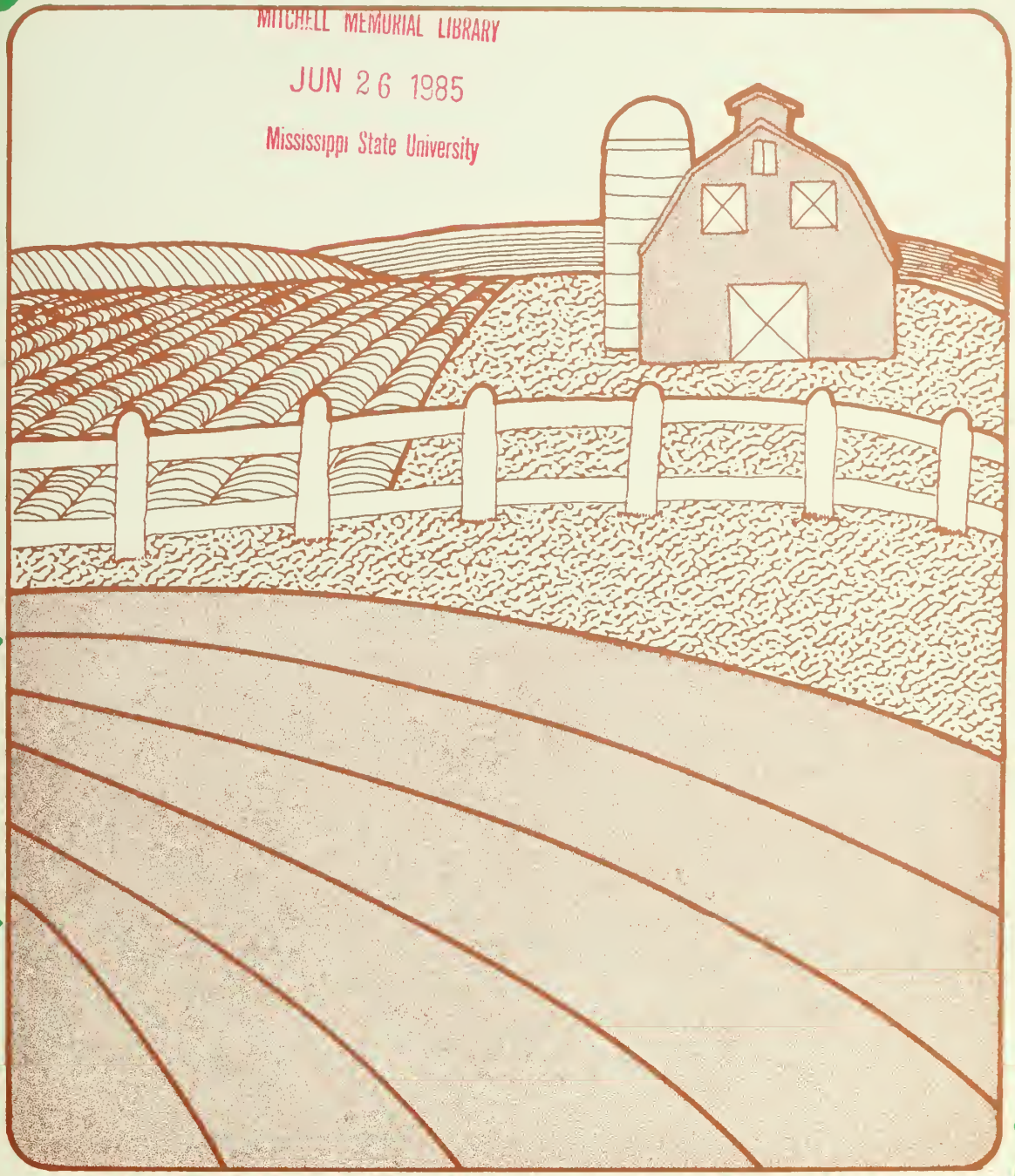

SLOSS (Soil Loss) An Interactive Model for Microcomputers

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SLOSS (Soil Loss)
An Interactive Model for Microcomputers

This report details the use of a soil-loss model for use on microcomputers. The model was developed to help extension, education and soil conservation personnel estimate the impact of various conservation treatments and for answering "what if?" questions about alternative combinations of soil conservation practices. The basis of the model is the USLE (Universal Soil-Loss Equation). The USLE is the most widely used soil-loss equation available. It encompasses the major factors pertaining to erosion in a relatively simple methodology. The SLOSS model is designed to assist in the application of the USLE by leading the user through a series of questions in an interactive program.

The model is "friendly" and will alert the user if inputs seem to be out of line. Accuracy is dependent on the completeness and correctness of each input, and inaccurate input data cannot be expected to yield useful results. SLOSS uses the lumped parameter approach so that inputs are minimal and cannot be expected to be as accurate as sophisticated modeling procedures, especially for unusual conditions. Each input is described, and examples of the procedures are included in this manual.

The USLE resulted from more than 10,000 plot years of data that related erosion rate to physical and management variables at each site. The SLOSS model is designed to estimate average annual soil loss resulting from a specific set of crop, soil, management and climatic conditions. The SLOSS model predicts the gross erosion from the field under consideration because it is based on the USLE. A short explanation of the terms in the equation is presented to assist the user in understanding the methodology. The user is referred to Wischmeier and Smith (1978) for additional information.

The Universal Soil-Loss Equation as given by Wischmeier and Smith (1978) is

$$A = RKLSCP$$

where

- A = average annual soil loss (tons/acre)
- R = rainfall runoff erosivity index
- K = soil erodibility factor as average soil loss per unit of erosion index (R) for a particular soil as measured on a unit plot
- LS = length-slope factor that accounts for topography
- C = cover-management factor as the ratio of soil loss from an area with specified cover and management to an identical area in tilled continuous fallow
- P = practice factor as the ratio of soil loss with conservation practices like contouring, strip-cropping or terracing to that of up-and-down-slope farming.

The significance of each factor will be discussed because selection of practices by the user is dependent on a general knowledge of the principles and factors on which the equation is based.

Rainfall-Runoff Erosivity Index (R)

The rainfall-runoff erosivity index accounts for the interrelationship of the erosion forces of falling rain and those of flowing water (runoff). Wischmeier (1959) analyzed momentum, kinetic energy, maximum 30-minute intensity, drop diameter, drop velocity and interactions of these characteristics. This evaluation showed that the product of rainfall energy and the maximum 30-minute intensity was the best indicator of rainfall erosivity. The combination of two terms indicates the combined effects of particle detachment and flow transport. These factors are important because detachment and transport must occur for soil loss to take place. Thus the rainfall-runoff erosivity index for a single storm could be calculated using

$$R = EI_{30/100}$$

where

- R = rainfall-runoff erosivity index
- E = kinetic energy (foot-tons/acre-inch)
- I = maximum 20-minute intensity (inches/hour).

The factor 100 is used to obtain a more manageable fraction. Wischmeier (1959) found that the kinetic energy of rainfall could be expressed as

$$E = 916 + 331 \log_{10} I$$

where

- E = kinetic energy,
- I = intensity.

One does not have to estimate rainfall intensity and energy to calculate R. An isoerodent map can be used to find local values for R. The map (Figure 1) is read as a topographic map is read except that the isoerodents are lines of constant erosion index rather than contour lines. Values are interpolated for locations between the lines. As indicated, the R-factor is based on geographical location. Figure 1 shows average annual R-factors. Soil loss for periods other than a calendar year also can be computed by adjusting the R-factor. This procedure will be illustrated later.

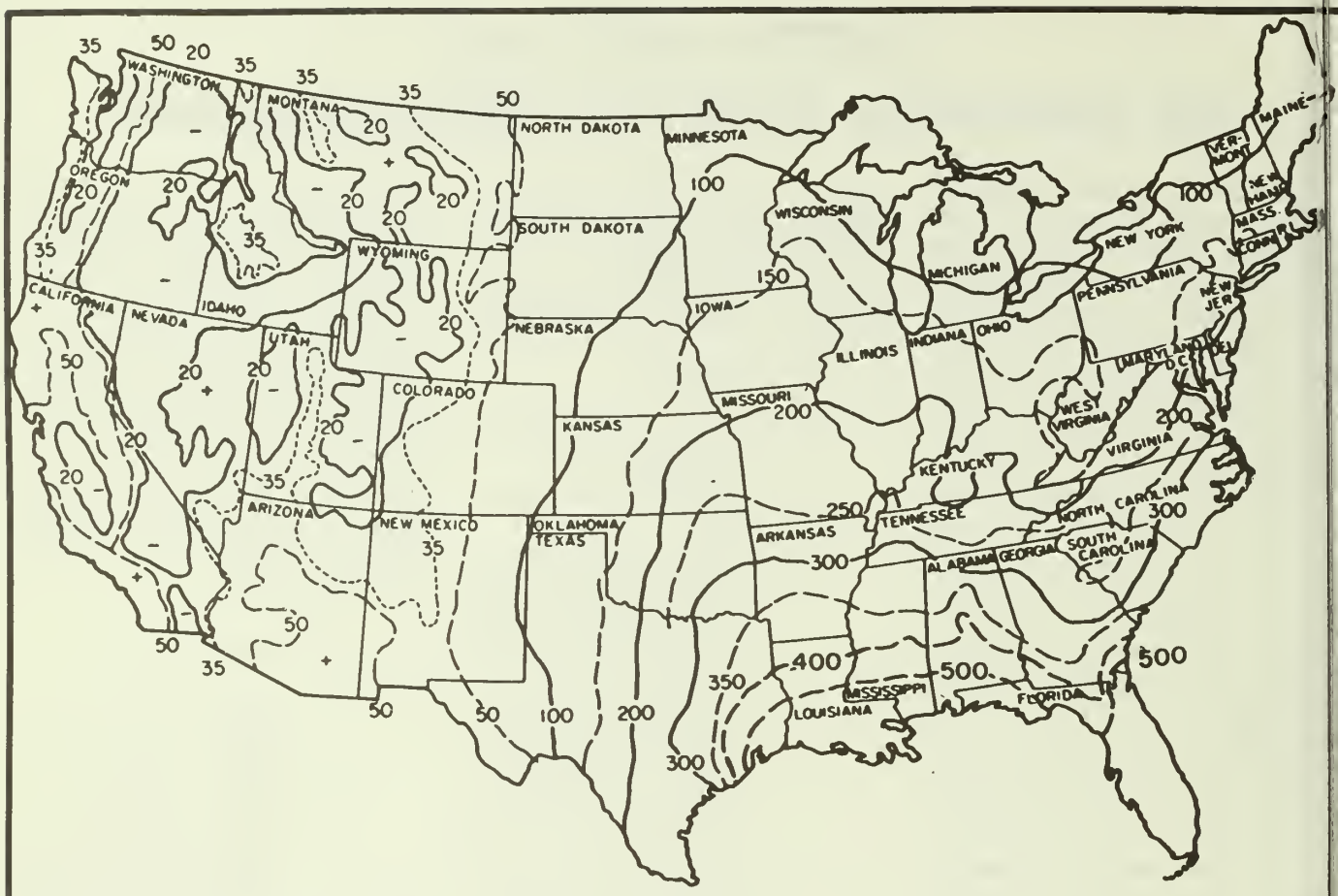

Figure 1. Average annual R factors for various areas of the United States.

Soil Erodibility Factor (K)

The soil erodibility factors (K) used in the USLE and in the SLOSS model are based on quantitative, experimentally determined values obtained from direct soil-loss measurements. The K-factor attempts to account for the susceptibility of a soil to erosion. It includes the interrelated effects of the resistance of a soil to detachment by rainfall and flowing water together with the soil's infiltration characteristics. Some selected soil erodibility factors, such as soil texture and organic matter (Schwab, et al.), are included (Table 1).

More accurate values for local soil types may be available from the Soil Conservation Service or other agencies. Wischmeier, et al. (1971) developed the nomograph (Figure 2) that can be used to find the K-factor of other conditions. Note that, if information about the permeability and soil structure is not available, a first approximation of K is based on textural information and percent organic matter only. More recent studies on high-clay subsoils have found much higher erodibility factors than those found using the nomograph shown in Figure 2 (Barfield, et al., 1981).

The K-factor takes into account only soil characteristics. The effects of tillage, cover and management will be considered in other factors.

Length-Slope Factor (LS)

The length-slope factor (LS) accounts for the effect of topography on soil loss. Originally, the plots used in the development of the USLE were 72.6 ft long on a slope. In the development of USLE, these conditions were gi an LS value of unity (LS = 1 Other LS factors are ratios of loss at specified lengths and slo to the standard of 72.6 ft and Slope length is the distance betw the point where overland fl begins and the downslope p where deposition occurs or the fl enters a defined channel. An nomograph was developed by Soil Conservation Service (19 for uniform slopes. The nomogra (Figure 3) developed by Wischme and Smith (1978) simplifies the e mation of the length-slope fac SLOSS will compose LS after user enters the slope length a percent slope of the field.

Table 1. Selected Soil Erodibility Factors (K) by soil Texture.

Textural Class	Organic Matter Content (%) 0.5	2	4
Fine sand	0.16	0.14	0.10
Very fine sand	0.42	0.36	0.28
Loamy sand	0.12	0.10	0.08
Loamy fine sand	0.44	0.38	0.30
Sandy loam	0.27	0.24	0.19
Very fine sandy loam	0.47	0.41	0.33
Silt loam	0.48	0.42	0.33
Clay loam	0.28	0.25	0.21
Silty clay loam	0.37	0.32	0.26
Silty clay	0.25	0.23	0.19

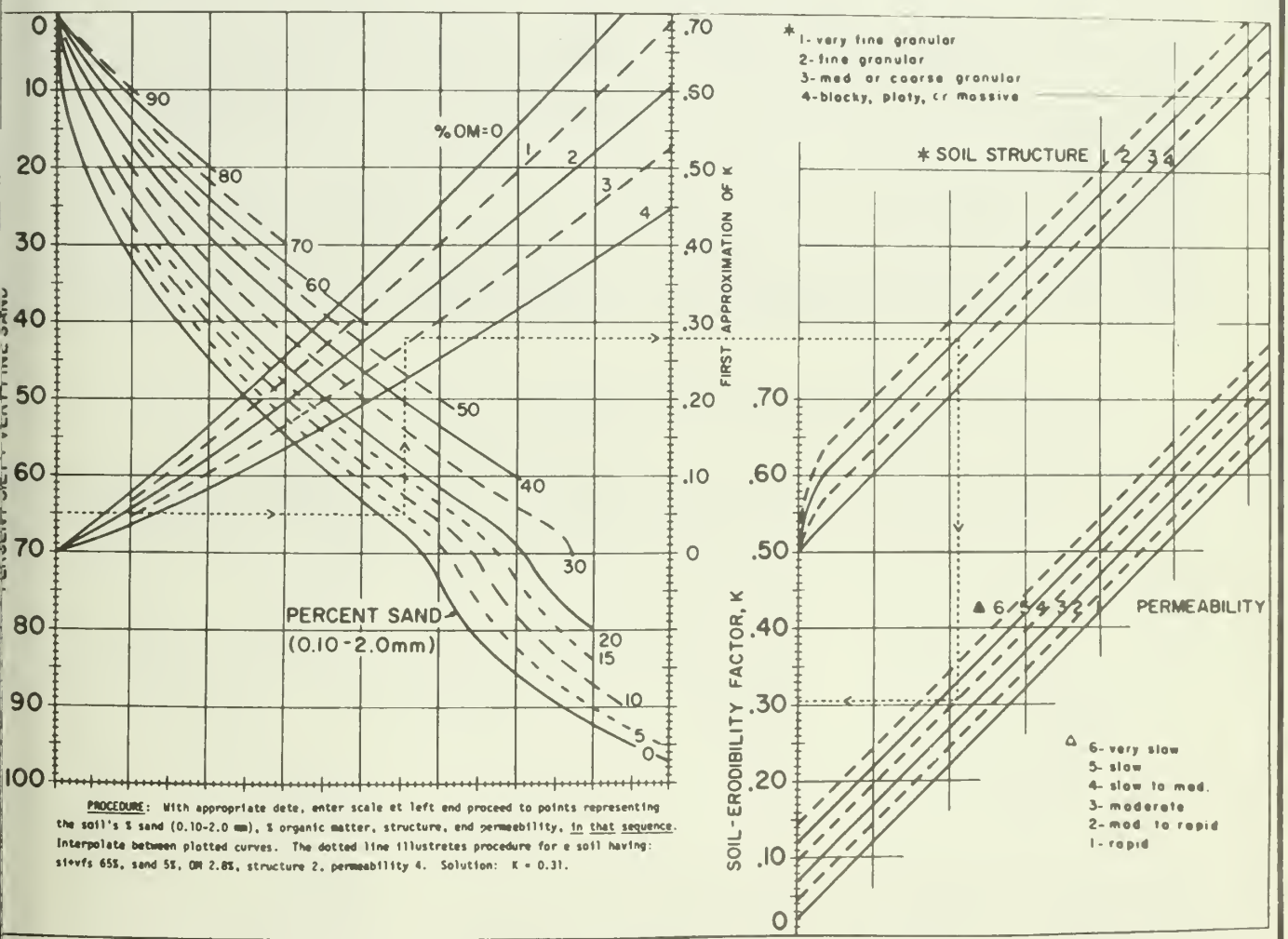
PERCENT SAND
(0.10-2.0mm)
%OM=0
FIRST APPROXIMATION OF K
SOIL-ERODIBILITY FACTOR, K
* SOIL STRUCTURE
PERMEABILITY
1- very fine granular
2- fine granular
3- med or coarse granular
4- blocky, platy, or massive
6- very slow
5- slow
4- slow to med.
3- moderate
2- mod to rapid
1- rapid
PROCEDURE: With appropriate data, enter scale at left and proceed to points representing the soil's % sand (0.10-2.0 mm), % organic matter, structure, and permeability, in that sequence. Interpolate between plotted curves. The dotted line illustrates procedure for a soil having: sivfs 65%, sand 5%, OM 2.8%, structure 2, permeability 4. Solution: K = 0.31.

Figure 2. Nomograph for calculating K factor under differing conditions.

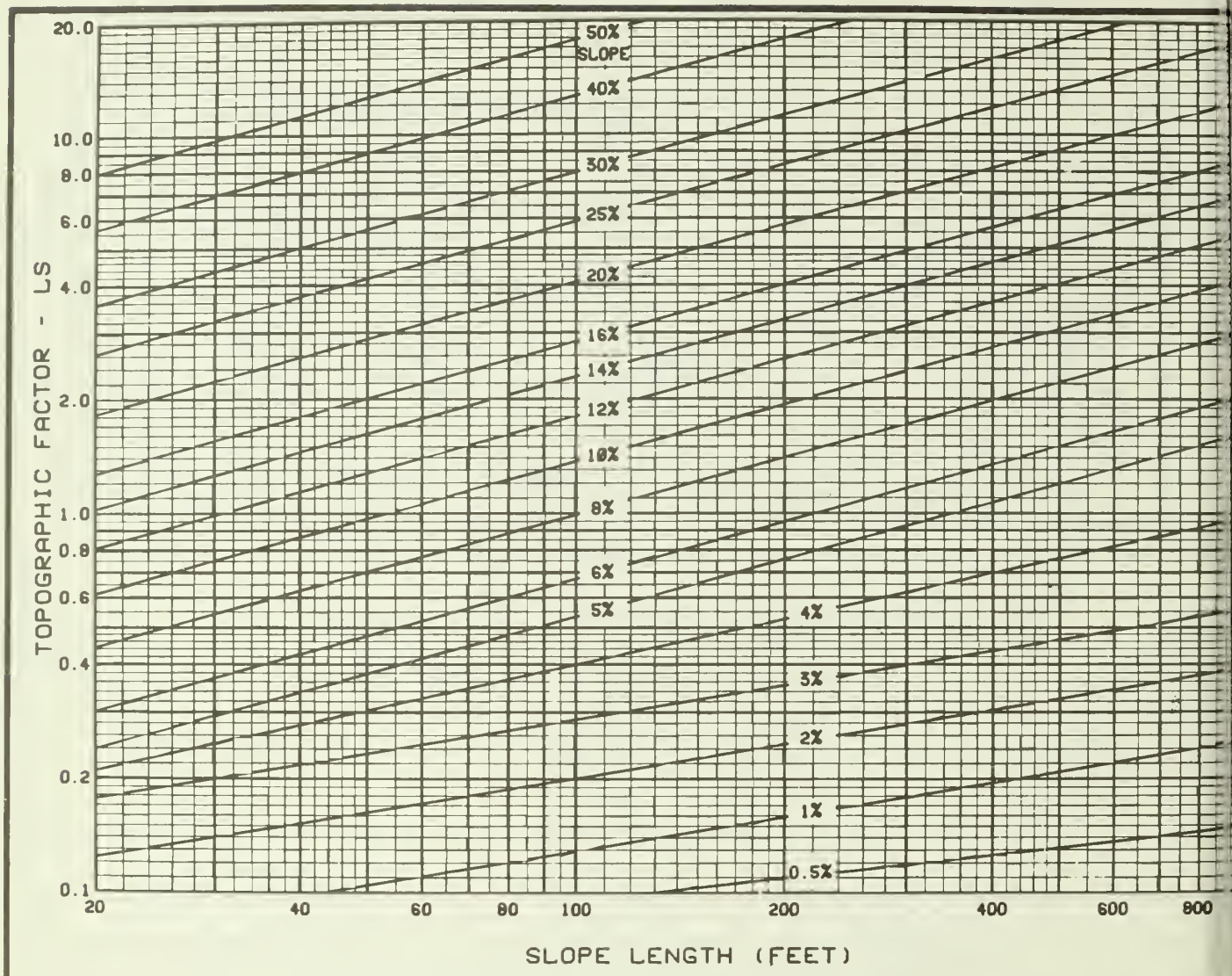

Figure 3. A nomograph which simplifies estimation of the length-slope factor.

Cover-Management Factor (C)

The cover-management factor (C) considers the combined effects of cover, tillage practices, residue, crop sequencing and the anticipated time distribution of erosive rains. In USLE development, the C-factor was defined as unity for continuous fallow. The C-factor involves the variable in the USLE that can vary over the widest range for a specific location. For example, it can vary from about .01% for undisturbed woodland having complete ground cover and canopy closure to 100% for bare-fallow conditions. Values for the C-factor for the crop-stage period as a ratio of the soil loss for crops to that of continuous fallow are presented in Table 2 for selected crop stages (Wischmeier and Smith, 1978). The time distribution of the rainfall-runoff erosivity index varies with geographic location.

The C-factor is typically expressed as an annual value for a particular cropping-management combination to simplify the soil-loss computations. Soil loss is dependent on cover and residue management because these affect the amount of protection provided the soil. Because the C-factor changes as a function of growth stage (Table 2) and rainfall energy and intensity patterns are not uniform throughout the year (Figure 4), crop-stage C-factors must be weighted proportionally to t appropriate percentages of t average annual erosivity ind (Table 3).

Accumulated percentages of t average annual R-factor as a fur tion of time throughout the ye (Table 4) for geographical areas the eastern United States we determined from Figure (Wischmeier and Smith, 197 Similar information is available the same reference for other cro and locations. SLOSS permits t option of entering the annual factor, computing a time-weight C-factor that weights according the proportion of the year and cr stage or computing an EI-S weigh

Table 2. Selected C-Factors from Cropland as a ratio percentage of the Corresponding Loss from Continuous Fallow (Wischmeier and Smith, 1978).

Crop Sequence and Tillage[a]	Spring residue	Cover after plant	C-factor for cropstage period[b]					
			F	SB	1	2	3	4
	Lb	%	----------			%		----------
CORN AFTER C, GS, G or COT IN MEADOWLESS SYSTEMS								
Moldboard plow, conv. till:								
1. RdL, sprg TP	3,400	--	36	60	52	41	20	30
2. RdL, fall TP	GP	--	49	70	57	41	20	--
3. RdR, sprg TP	GP	--	67	755	66	47	23	62
4. RdR, fall TP	GP	--	77	83	71	50	23	--
5. No-till plant in crop residue	6,000	90	--	3	3	3	3	14
No-till plant in crop residue	3,400	70	--	8	8	8	6	19
CORN IN SOD-BASED SYSTEMS								
No-till pl in killed sod:								
6. 3 to 5 hay yld	--	--	--	1	1	1	1	1
Strip till, 1-2 meadow:								
7. 40% cover, tilled strips	--	--	--	4	4	4	4	6
CORN AFTER SOYBEANS								
8. Sprg, TP, conv till	GP	--	47	78	65	51	25	37
9. Fall TP, conv till	GP	--	53	81	65	51	25	--
10. Fall & Sprg chisel or cult	GP	25	--	45	39	33	23	37
11. No-till pl in crop res'd	GP	30	--	33	29	25	14	33
BEANS AFTER CORN								
12. Sprg, TP, RdL, conv till	GP	--	39	64	56	41	18	28
13. Fall TP, RdL, conv till	GP	--	52	73	61	41	18	46
GRAIN AFTER C, G, GS, COT								
14. Disked-in residues	3,400	60	--	16	14	12	2	30
PERMANENT MEADOW								

a Symbols: C - Corn; GS - Grain Sorghum; G - Small Grain; COT - Cotton; RdL - Residue left on field; RdR - Residue Removed; GP - Good Productivity; TP - Turnplow; F - Fallow; SB - Seedbed

Period F (rough Fallow) - Inversion plowing to secondary tillage.
Period SB (seedbed) - Secondary tillage for seedbed preparation until the crop has developed 10 percent canopy cover.
Period 1 (establishment) - End of SB until crop has developed a 50 percent canopy cover. (Exception: Period 1 for cotton ends at 35 percent canopy cover.)
Period 2 (development) - End of Period 1 until canopy cover reaches 75 percent.
Period 3 (maturing crop) - End of Period 2 until crop harvest. This period was evaluated for three levels of final crop canopy.
Period 4 (residue or stubble) - Harvest to plowing or new seeding.

(1) Periods selected to coincide with cropstage periods used in Table 2.
(2) Dates for each cover condition in column (1).
(3) Percentages of cumulative R (Table 3) at end of interval in column (2).
(4) Incremental differences between values in column (3).
(5) Percentage of C-factor for cropstage period indicated in column (1) taken from Table 2.
(6) Product of column (4) and column (5). The sum of column (6) is the average annual C-factor.

l C-factor that weights accordings EI distribution and crop stage. n example of the procedure the mputer uses to compute the time- eighted C-factor will suffice to ustrate the use of the charts to otain an average annual C.

Example 1.

Calculate the average annual C-factor for continuous corn with the following data specified: The corn is grown near Starkville, Mississippi (geographical area 22, from Figure 5), turnplowed - March 1; disked - April 1; planted - April 15; harvested - September 1. Assume that the residue is left on the field. (See table 3 for solution.)

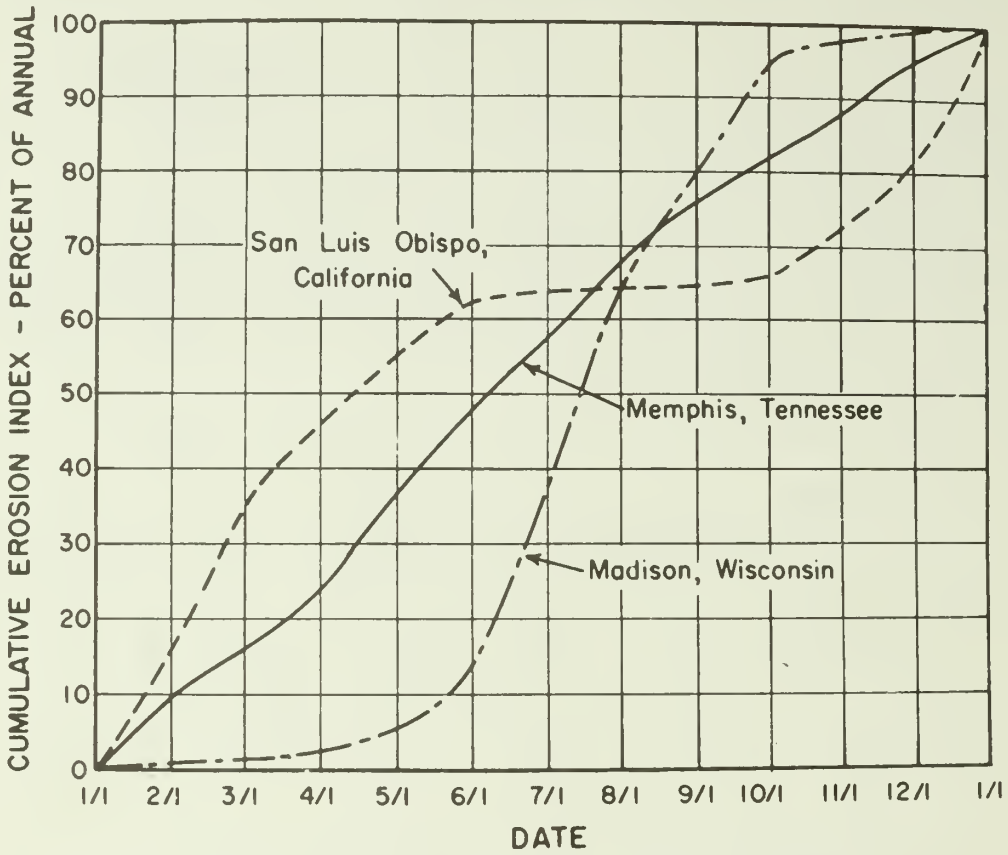

Figure 4. Cumulative erosivity index reveals non-uniform rainfall patterns.

Table 3. Calculated C factors for continuous corn, by periods.[1]

Period[1]	Dates[2]	% of Cum. R[3]	Incr. % of R.[4]	C-factor for Stage (%)[5]	C for Incr[6]
Residue (4)	1/1-3/1	13	13	30	0.0390
Fallow (F)	3/1-4/1	21	8	36	.0288
Seedbed (SB)	4/1-5/15	38	17	60	.1020
Establishment (1)	5/15-7/1	55	17	52	.0884
Development (2)	7/1-8/8	67	12	41	.0492
Maturing Crop (3)	8/1-9/1	75	8	20	.0160
Residue (4)	9/1-12/31	100	25	30	.0750
					= 0.3984

Average Annual C = 0.40 = 40%

[1]Periods selected to coincide with cropstage periods used in Table 2.
[2]Dates for each cover condition in column (1).
[3]Percentages of cumulative R (Table 3) at end of interval in column (2).
[4]Incremental differences between values in column (3).
[5]Percentage of C-factor for cropstage period indicated in column (1) taken from Table
[6]Product of column (4) and column (5). The sum of column (6) is the average annual C-factor.

Practice Factor (P)

The conservation-practice factor (P) in the USLE represents the ratio of soil loss with a specified practice to the corresponding loss with up-and-down-slope farming, which has a P-factor of unity (P = 1.0). The practice factor reflects the influence of contour tillage, strip-cropping along the contour and terrace systems. These practices tend to disturb the overland flow of runoff so that large quantities of water do not cause movement of large amounts of soil. Recommended P-factors for various conditions are shown in Table 5 (Wischmeier and Smith, 1978).

Table 4. Accumulated Percentage of the Average Annual R between January 1 and Specified Oate (Wischmeier and Smith, 1978).

	JAN.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.	
Area No.	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15
1	0	0	0	0	0	0	1	2	3	6	11	23	36	49	63	77	90	95	98	99	100	100	100	100
2	0	0	0	0	1	1	2	3	6	10	17	29	34	55	67	77	85	91	96	98	99	100	100	100
3	0	0	0	0	1	1	2	3	6	13	23	37	51	61	69	78	85	91	94	96	98	99	99	100
4	0	1	1	1	2	3	4	7	12	18	27	38	48	55	62	69	76	83	90	94	97	98	99	100
5	0	3	2	3	4	6	8	13	21	29	37	46	54	60	65	69	74	81	87	92	95	97	98	99
6	0	0	0	0	1	1	1	2	6	16	29	39	46	53	60	67	74	81	88	95	99	99	100	100
7	0	2	1	2	3	4	6	8	12	25	40	49	56	62	67	72	76	80	85	91	97	98	99	99
8	0	5	3	5	7	10	14	20	28	37	48	56	61	64	68	72	77	81	86	89	92	95	98	99
9	0	6	4	6	9	12	17	23	30	37	43	49	54	58	62	66	70	74	78	82	86	90	94	97
10	0	1	2	4	6	8	10	14	21	29	38	47	53	57	61	65	70	76	83	88	91	94	96	98
11	0	1	3	5	7	9	11	15	18	27	35	41	46	51	57	62	68	73	79	84	89	93	96	98
12	0	0	0	0	1	1	2	3	5	9	15	27	38	50	62	74	84	91	95	97	98	99	99	100
13	0	0	0	1	1	2	3	5	7	12	19	33	38	57	65	74	82	888	93	96	98	99	100	100
14	0	0	0	1	2	3	4	6	9	14	20	28	39	52	63	72	80	87	91	94	97	99	99	100
15	0	0	1	2	3	4	6	8	11	15	22	31	40	49	59	69	78	85	91	94	96	98	99	100
16	0	1	2	3	4	6	8	10	14	18	25	34	45	56	64	72	79	84	89	92	95	97	98	99
17	0	1	2	3	4	5	6	8	11	15	20	28	41	54	65	74	82	87	92	94	96	97	98	99
18	0	1	2	4	6	8	10	13	19	26	34	42	50	58	53	68	74	79	84	89	93	95	97	99
19	0	1	3	6	9	12	16	21	26	31	37	43	50	57	64	71	77	81	85	88	91	93	95	97
20	0	2	3	5	7	10	13	16	19	33	27	34	44	54	63	72	80	85	89	91	93	95	96	98
21	0	3	6	10	13	16	19	23	26	29	33	39	47	58	68	75	80	83	86	88	90	92	95	97
22	0	3	6	9	13	17	21	27	33	38	44	49	55	61	67	71	75	78	81	84	86	90	94	97
23	0	3	5	7	10	14	18	23	27	18	35	39	45	53	60	67	74	80	84	6o	88	90	93	95
24	0	3	6	9	12	16	20	24	28	33	38	43	50	59	69	75	80	84	87	90	92	94	96	98
25	0	1	3	5	7	10	13	17	21	24	27	33	40	46	53	61	69	78	89	92	94	95	97	98
26	0	2	4	6	8	12	16	20	25	30	35	41	47	56	57	75	81	85	87	89	91	93	95	97
27	0	1	2	3	5	7	10	14	18	22	27	32	37	46	58	69	80	89	93	94	95	96	97	99
28	0	1	3	5	7	9	12	15	18	21	25	29	36	45	56	68	77	83	88	91	93	95	97	99
29	0	1	2	3	4	5	7	9	11	14	17	22	31	42	54	65	74	83	89	92	95	97	98	99
30	0	1	2	3	4	5	6	8	10	14	19	26	34	45	56	66	76	82	86	90	93	95	97	99
31	0	0	0	1	2	3	4	5	7	12	17	24	33	42	55	67	76	83	89	92	94	96	98	99
32	0	1	2	3	4	5	6	8	10	13	17	22	31	42	52	60	68	75	80	85	89	92	96	98
33	0	1	2	4	6	9	11	13	15	18	21	26	32	38	46	55	64	71	77	81	77	81	93	97

Table 5. Practice Factors (P).

Percent slope	P contouring (max. slope length)	P strip crop (max. strip width)	Graded channels sod outlets	Steep back underground outlet
	ft			
1-2	.60 (400)	.45 (800)	.12	.05
3-8	.50 (300)	.30 (600)	.10	.05
9-12	.60 (120)	.45 (240)	.12	.05
13-16	.70 (80)	.52 (160)	.14	.05
17-20	.80 (60)	.60 (120)	.16	.06

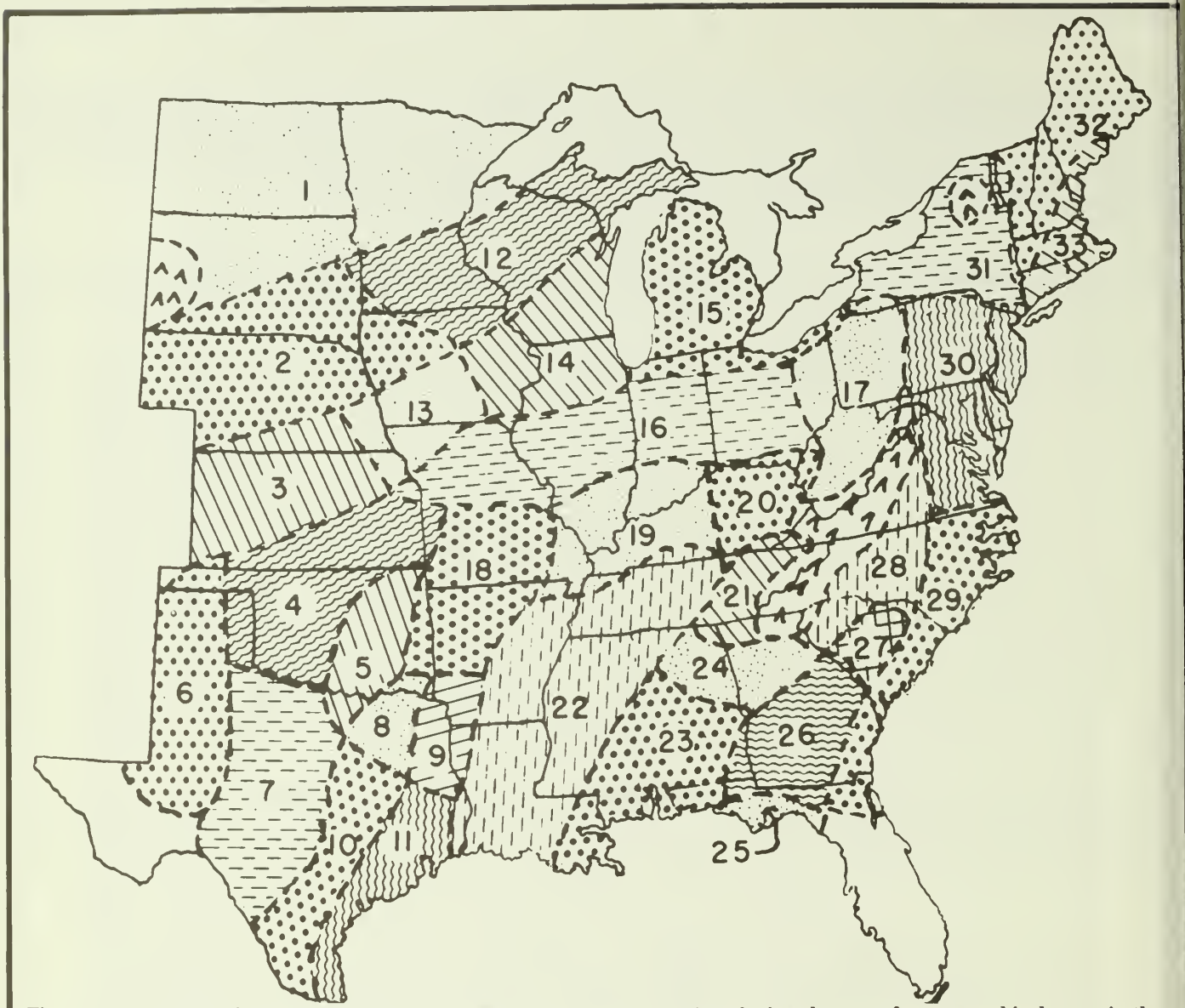

Figure 5. Accumulated percentages of the average annual R-factor by time during the year, for geographical areas in the Eastern United States.

Organization and Features

SLOSS begins operation by printing some initial statements and prompting the user to declare the number of fields to be considered (Figure 6-A). Calculation of soil loss from multiple fields permits convenient comparison of two or more management schemes from the standpoint of erosion control. An areal weighted average will be computed from the soil loss of all fields considered for use as a baseline mean-annual soil-loss value. A help routine (Figure 6-E) is accessible from any prompted input that provides an explanation of the prompted input term where the "Help" request originates throughout SLOSS.

Once the number of fields has been declared, SLOSS obtains K, P, L and S values for each field (Figure 6-B). Inputs for K and P are checked for conformity to published and nomograph-derivable values. If values deviate from the normal range, the user is warned and prompted for another value. The program aborts operation if three incorrect K values are entered. This feature may help people who are not familiar with the USLE. All entered values are displayed for subsequent editing (if needed) following the entry of the last variable from the last field (Figure 6-C).

SLOSS collects C and R values after the field data have been edited. The three methods permitted for

evaluating C and R (Figure 6-D) are (1) simple single annual C and R value, (2) time-weighted C and R value and (3) EI-weighted C with R value. The user chooses the method for entering C and R data on a by-field basis. Editing of input data is permitted before the field counter is advanced.

When all fields have been assigned appropriate C and R values soil loss in tons per acre per year is displayed for each field, with the mean soil loss for all the fields combined. A hard (printed) copy of all terms and the computed soil-loss rate can be obtained. Additional computation may be initiated (Figure 6-F), with the option to edit the old field data set, go to C, begin with a totally new field data set or go to A. If no further computations are wanted the program terminates accordingly. Improper responses to input prompts may terminate or extend program execution; therefore, it is imperative to *READ* the prompts.

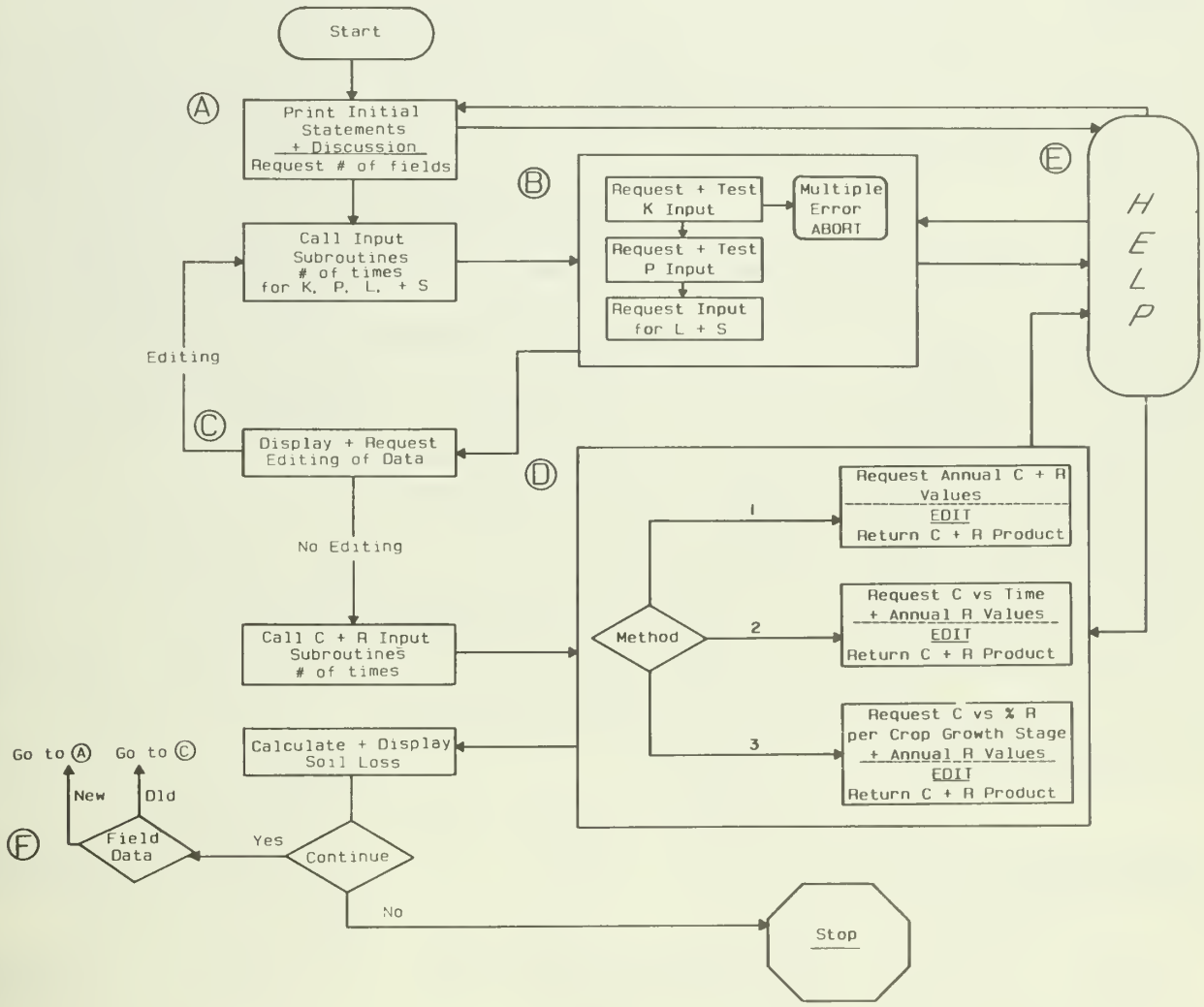

Figure 6. Steps to be followed in using SLOSS interview model for microcomputers.

OPERATIONAL EXAMPLES

The examples that follow should aid the user in further understanding the use of the soil-loss factors used in the USLE and the operation of SLOSS. The examples use the interactive feature of the SLOSS model to illustrate user program operation.

Example 2a

Given a 70-acre field located near Memphis, Tennessee, calculate the average annual soil loss per year while implementing the following cropping system:

Crop - continuous corn; turn-plowed March 9, Seedbed April 15, Harvested September 1 and crop residue left on the field.

Field Length - 300 feet; field slop 10%.

Soil conditions - 65% silt and fine sand, 5% sand, 3% organic matter and fine grained, moderately drained.

Plowed up-and-down slope.

Based upon the given conditions, R=310 (Figure 1), K=.27 (Figure 2) and LS=2.4 (Figure 3), the user enters a slope of 10% and a field length of 300 feet. The model determines the LS-factor, C=4 (using the average annual C from Example 1) and P=1 from Table 5. Using the USLE (A=RKLSCP), the average annual soil loss from this field is about 80 tons per acre.

The following illustrates the same example with user inputs and model responses and results:

```
RUN
Agronomy and Agricultural Engineering Departments
Mississippi State University
  1983
Louis Baumhardt - Tony Trent
John C. Hayes
<Depress Any Key To Start Program>

This Program estimates SOIL LOSS from a field using the UNIVERSAL SOIL LOSS EQUATION. If you are not familiar with the Universal Soil Loss Equation - STOP and read the manual that came with this program. If you have read the manual and are ready to proceed -
<Depress Any Key To Continue>
          -R-E-M-E-M-B-E-R-
This program ESTIMATES soil loss and depends upon the correctness of the information that you enter. If you start and need HELP at any time just type the word 'HELP' <ENTER> and assistance will be provided. If you are ready we will get started.<Depress any key>. We can look at all or just some of the fields that make up a farm.
How many fields do you want to consider? (10 max)
? 1
How many acres in Field- 1
?70
Enter the Soil Erodibility Factor (K) for the soil in field- 1
? .27
What is the Conservation Practice Factor (P) for Field- 1
? 1.0
What is the % Slope for Field- 1
? 10
Enter the length of the slop- in FEET
? 300
FIELD DATA EDITOR
 Field ACRES K P Slope Length
   1     70   .27 1   10     300
Any changes- YES or NO ?
? NO
CROP COVER FACTOR METHODS:
1. Unweighted
2. Weighted
3. Weighted Rainfall Erosivity Factor (R)
Field- 1
Method+ ? 1
Enter Crop Cover Factor (%)? 40
Crop Cover Factor- Field 1 = 40
CHANGE-YES or NO
? NO
Enter Rainfall Erosivity Factor (R)?
310
                SOIL LOSS
Field      Soil Loss (Tons/Acre)
-------    ---------------------
  1              79.443
<Depress -H- for hard copy or -C- continue>

FIELD  Acres   K   P   =Slope  Length-  C    R    I
  1      70   27   1     10      300    40   310  ?

Another Problem-YES or NO
```

Example 2b

Using the same field, calcula the average annual C-factor an average annual soil loss for th following system:

Crop - corn after soybean with spring TP and conventiona tillage and contour plowing

From previous and given condition R=310, P=.6 (Table 5), LS=2.4 an K=.27. The EI weighted C-factor will be determined by the mod using the time-distribution of rai fall-runoff erosivity index and th corresponding C-factor as illustra ed by the following user inputs columns (3) and (5) in Table (geographical area 22 from Figu 5).

(1)	(2)	(3) %of	(4) Incr. %	(5) C-factor	
Period	Dates	CumR	ofR	for Stage %	fo
Residue	1/1-3/1	13	13	37	
Fallow (F)	3/1-4/1	21	8	47	
Seedbed (SB)	4/1-5/1	33	12	78	
Establishment (1)	5/1-6/15	49	16	65	
Development (2)	6/15-8/1	67	18	51	
Maturing Crop (3)	8/1-9/15	78	11	25	
Residue (4)	9/15-12/31	100	22	37	
					=
				Average annual C=	

```
Another Problem-YES or NO
? YES
CHOOSE ONE
1. New Field Data Set
2. Modify Existing Field Data S
<2>
FIELD DATA EDITOR
 Field ACRES K P Slope Lengt
   1     70   .27 1   10     300

Any changes- YES or NO ?
? YES
In which Field? ? 1
Which Factor? P
Field- 1 P = 1
Enter new value
? .6
```

FELD DATA EDITOR
Feld ACRES K P Slope Length
1 70 .27 .6 10 300
Ay changes- YES or NO ?
?NO
CROP COVER FACTOR METHODS:
1 Unweighted
2 Weighted
3 Weighted Rainfall Erosivity Factor (R)
Feld- 1
Methods= ? 3
his method calculates soil loss sed on time periods. More than e time period may be entered. me periods must be entered in quence from earliest to latest.
nter the beginning date of the st time period- MM/DD/YY
01/01/83
nding Date Time Period- 1
03/01/83
nter the Crop Cover Factor % for is period? 37
nother Time Period- YES or NO ?
ES
nding Date Time Period- 2
04/01/83
nter the Crop Cover Factor for is period? 47
nother Time Period- YES or NO ?
ES
nding Date Time Period- 3
05/01/83
nter the Crop Cover Factor for is period? 78
nother Time Period- YES or NO ?
ES
nding Date Time Period- 4
06/15/83
nter the Crop Cover Factor for is period? 65
nother Time Period- YES or NO ?
es
nding Date Time Period- 5
08/01/83
nter the Crop Cover Factor for is period? 51
nother Time Period- YES or NO ?
ES
nding Date Time Period- 6
09/15/83
nter the Crop Cover Factor for is period? 25
Another Time Period- 7
? 12/31/83
Enter the Crop Cover Factor for this period? 37
Another Time Period- YES or NO ?
NO
Initial Time - 01/01/83

FIELD- 1

Time	Date	Cover Factor%
1	03/01/83	37
2	94/01/83	47
3	05/01/83	78
4	06/15/83	65
5	08/01/83	51
6	09/15/83	25
7	12/31/83	37

Any Changes - YES or NO
? NO
Enter Rainfall Erosivity Factory (R)?
310
Rainfall Erosivity Factor (R) = 310
Initial Time- 01/01/83
Input Initial % R Accumulated?

Time	Date	Cover Factor%
1	03/01/83	37

Enter % of R accumulated by Date? 13

2	04/01/83	47

Enter % of R accumulated by Date? 21

3	5/01/83	78

Enter % of R accumulated by Date? 33

4	06/15/83	65

Enter % of R accumulated by Date? 49

5	08/01/83	51

Enter % of R accumulated by Date? 67

6	09/15/83	25

Enter % of R accumulated by Date? 78

7	12/31/83	37

Enter % of R accumulated by Date? 100
Rainfall Erosivity Factor = 310

Time	Date	C	%R
1	03/01/83	37	13
2	04/01/83	47	21
3	05/01/83	78	33
	06/15/83	65	49
5	08/01/83	51	67
6	09/15/83	25	78
7	12/31/83	37	100

Any changes- YES or NO ?
? NO

SOIL LOSS

Field	Soil Loss (Tons/Acre)
	57.67

<Depress -H- for hard copy or -C- to continue>

FIELD	Acres	K	P	Slope	Length	C	R	Soil Loss
1	70	.27	.6	10	300	48	310	57.67

Another Problem- YES or NO

Example3

Determine the average annual soil loss from two fields located near Des Moines, Iowa, with the following conditions:

Field 1
30 acre
Permanent pasture
Field length - 800 feet
Field slope - 8%
Soil - silty clay loam .5% o.m.
Field is contour terraced with previously established terraces in corn with 200 feet between terraces

Field 2
55 acres
Permanent pasture
Field length - 1,000 feet
Field slope - 2%
Soil - very fine sandy loam 4% o.m.
Field is contour terraced (same as Field 1)

From the given conditions the soil loss factors were determined for each field.

Field 1	**Field 2**
R = 170 (Figure 1)	R = 170 (Figure 1
C = .4% (Table 2)	C = .4% (Table 2)
L = 200 feet	L = 200 feet
S = 8%	S = 2%
K = .27 (Table 1)	K = .33 (Table 1)
P = .10 (Table 5)	P = .12 (Table 5)

It should be noted that the slope length entered by the user is the length between terraces and not the length of the field. By comparison if the field was not terraced, the field length should be entered along with a new P-factor.

Another Problem- YES or NO
?YES
CHOOSE ONE
1. New Field Data Set
2. Modify Existing Field Data Set
<2>
We can look at all or just some of the fields that make up a farm.
How many fields do you want to look at? (10 max)
? 2
How many acres in Field- 1
? 30
Enter the Soil Erodibility Factor (K) for the soil in field- 1
? .37
What is the Conservation Practice Factor (P) for Field- 1
? .1

What is the % Slope for field- 1
? 8
Enter the length of the slope- in FEET
? 200
How many acres in Field- 2
? 55
Enter the Soil Erodibility Factor (K) for the soil in field- 2
? .33
What is the Conservation Practice Factor (P) for Field- 2
? .12
What is the % Slope for Field- 2
? 2
Enter the length of the slope- in FEET
? 200

FIELD DATA EDITOR

Field	ACRES	K	P	Slope	Length
1	30	.37	.1	8	200
2	55	.33	.12	2	200

Any changes- YES or NO ?
? NO

CROP COVER FACTOR METHODS:
1. Unweighted
2. Weighted
3. Weighted Rainfall Erosivity Factor (R)
Field- 1
Methods = ? 1
Enter Crop Cover Factor % ? .4
Crop Cover Factor- Field 1 = .4
Changes- YES or NO
? NO
Enter Rainfall Erosivity Factor (R)?
170
CROP COVER FACTOR METHODS:
1. Unweighted
2. Weighted
3. Weighted Rainfall Erosivity Factor (R)
Field- 2
Method = ? 1
Enter Crop Cover Factor? .4
Crop Cover Factor- Field 2 = .4
CHANGES- YES or NO
? NO

Enter Rainfall Erosivity Factor
? 170
SOIL LOSS

Field	Soil Loss (Tons/Acre)
1	0.04
2	0.01

Total Soil Loss = .477855 Tons/Ac
<Depress -H- for hard cropy or -
continue>

FIELD	Acres	K	P	Slope	Length	C	
1	30	.37	.1	8	200	.4	
2	55	.33	.12	2	200	.4	

Total Soil Loss- 0.02 Ton per A
Another Problem- YES or No
?

Comparison of the three previ examples should illustrate the v range of soil loss values result from changing the C and P fact As mentioned previously, the res are only as good as the input d used and the data must accura reflect the cropping and mana ment systems.

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Effect of Location and Diet on Performance and Profitability of Finishing Mississippi Beef Steers After Winter Grazing

MAFES MISSISSIPPI AGRICULTURAL & FORESTRY EXPERIMENT STATION
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Effect of Location and Diet on Performance and Profitability of Finishing Mississippi Beef Steers After Winter Grazing

Finishing cattle to slaughter eight is rarely considered as an lternative by producers in Mississippi. However, changes in costs nd returns associated with changng feed costs and (or) cattle prices ould make cattle finishing a plausle alternative for Mississippi producers.

The two generally accepted finishng options that Mississippi producers can use are (1) build the necessary facilities and finish cattle on a grain or silage ration or (2) send the cattle to a feedlot in the Southwest for custom finishing.

Comparing the costs and returns associated with finishing cattle in Mississippi with those of custom finishing in the Southwest requires data for differences in performance due to environmental effects and diets fed at different locations and the effects of differences in costs of feed, transportation and other inputs associated with finishing cattle. The purpose of this study was to provide information about the effect of location and diet on the performance of finishing Mississippi steers after winter grazing and to present an economic analysis that relates costs and returns of finishing cattle to location and diet.

Description of Experiment

This experiment involved a cooperative effort of Mississippi State niversity, Texas A & M University nd Texas Tech University. Steers ere fed at three locations---two in lississippi and one in Texas.

The two Mississippi locations MAFES Brown Loam Branch at aymond and MAFES South Mississippi Branch at Poplarville) have ignificantly different feedlot facilies and represent different areas ithin the South Mississippi winter razing region. The Brown Loam eeding facility is an open lot with nsheltered concrete feeding bunks long one side. Trees within or djacent to the pens afford some hade. The South Mississippi feedlot acility has a concrete floor and is a ompletely covered facility. Pens re cleaned via a sloped floor-water ush arrangement.

The Texas Tech University Exeriment Station at Amarillo Texas as chosen to represent the Southest custom feedlot operation ecause its facilities are similar to any of the commercial feedlots in he region (open lots with unheltered fence-line feed troughs). Personnel from the Texas A&M Research and Extension Center helped coordinate the experiment, and personnel at the Texas Tech Research Center managed the steers fed in Texas and collected the feed, weight gain and carcass data.

In May 1980, 1981 and 1982, 120 steers (60 steers from the Brown Loam Branch and 60 from the South Mississippi Branch) were sorted by breed and weight and randomly assigned to one of five treatments. Steers from the Brown Loam Branch were Angus x Hereford crossbred calves that had been purchased in the fall and backgrounded on winter grazing systems. Steers from the South Mississippi Branch were born in late winter, weaned in October and backgrounded on wintergrazing systems. South Mississippi steers were produced from straight Hereford, Hereford x Barzona or Hereford x Beefmaster dams. Sires were Angus (1979); Angus, Brangus or Simmental (1980) and Brangus or Beefmaster (1981).

Steers were weighed individually, identified with ear tags, treated for internal parasites (TBZ paste®) and implanted with Ralgro® before confinement in the feedlots in Mississippi or shipment to Texas. Steers shipped to Texas were reweighed upon arrival at the feedlot.

A corn-cottonseed hull finishing diet was fed to three groups of steers, one group at each of the two Mississippi locations and one in Texas. A corn-silage finishing diet (considered by researchers to be the most economical Mississippi feedlot diet) was fed to one group of steers at the South Mississippi Branch. A milo-cottonseed hull finishing diet (considered by Texas researchers to be the most economical Texas feedlot diet) was fed to one group of steers at the Texas Tech Experiment Station.

Compositions of the three diets are presented in Table 1. Steers in each of the five groups were fed until they reached an average of about 1,100 pounds unshrunk weight. At the close of each feeding trial the steers were sold on a carcass yield and weight basis to local packers.

Data

Average weights of steers entering the feedlots ranged from 749 to 767 pounds. Assigned costs of steers at the beginning of feeding were based on market prices, as established from late May quotations on comparable animals each year. Interest at 15% (approximately the prevailing rate in each of the three years of the experiment) was charged on the initial cost assigned to the animals, and on feed cost. Five treatment groups were fed in each of three years in five "feeding periods" ranging in length from 11 to 36 days.[1] In 1981, steers were fed over only four feeding periods.

The prevailing bulk price of each feed ingredient at each location at the beginning of each feeding period was used to calculate diet cost/lb. The cost/lb times average daily consumption per head times the number of days in the feeding period yielded estimated diet cost per head for a specific lot over a specific feeding period.

Estimates of other costs per head for feeding cattle in Mississippi, as taken from a recent study (1), were utilities and fuel, $2.31; labor, $14.07 (4.2 hours @ $3.35); veterinary and medicine, $5.43; transportation and marketing, $7.50; and death loss, 1% of purchase price. Steers fed in Texas were charged transportation, averaging $31.62 per head; veterinary and medicine, $3.00; death loss, 2% of purchase price and service and facility cost, $15.00/ton of feed.

Table 1. Composition of finishing diets fed steers in Mississip and Texas, as-fed basis, 1980-1982

Item	Diet		
	Corn	Milo	Corn Silage[a]
	percent		
Corn, cracked	73.0	--	7.1
Milo, steamflaked	--	77.3	--
Corn silage	--	--	87.7
Cottonseed hulls	15.0	10.0	--
Cottonseed meal	6.0	.7	4.6
Molasses	--	6.0	--
Supplement			
Alfalfa, dehy	3.4	3.61	
Urea	.37	.37	
Polyphos	.17	.17	
Calcium carbonate	.60	.60	
Salt	.50	.50	
Ammonium sulfate	.36	.36	
Vitamin A	.0075	.0075	[b]
Trace mineral	.01	.01	
Sulfur	.02	.02	
Potassium chloride	.57	.57	
Rumensin	[c]	[c]	[d]
TM Salt			.2
Dicalcium phosphate			.1
Ground limestone			.3
Calculated Content:			
Dry matter (%)	89.5	88.4	45.0
Crude protein (% DM)	12.1	11.9	12.0
DE (Kcal/lb DM)	1428	1380	1440

[a] Based silage containing 8.02% CP (DM basis).

[b] 200,000 IU/hd/day.

[c] 500 grams/ton.

[d] 200 mg/hd/day.

Results

Differences in size and quality of steers entering a feedlot or in the feeding program at that lot over the three-year life of the project were only minor, and results are reported on a three-year average basis. (Annual data on feeding programs are available in appendices to this report).

Three-year average performance rates for steers at all locations are presented in Table 2. Inspection of average daily gain data---fro initial full weight to final shrun weight---reveals significantly high rates of gain in both Texas feedlo than in either of the two Missi sippi feedlots. In Mississippi, stee

[1] *Length of a feeding period was generally about 28 days but varied in the initial or last periods depending on changes in diet composition or animal size and remaining time in the feedlot.*

id at the Brown Loam Branch had significantly higher rate of gain an did those fed at the South Mississippi Branch. Feed conversion ratios did not differ appreciably except for steers fed the corn silage et at the South Mississippi ranch, which reflected the higher ater content of silage. More detailed data appear in appendix A.

Most of the significant differences carcass characteristics were in arcass weight and dressing percentage, with steers fed at the South Mississippi Branch producing significantly lower dressing percentages han those finished at the Texas tation or the Brown Loam Branch Table 3). There were no significant ifferences among marbling scores r USDA quality grades of steers d the different diets, or at different locations. Carcass yield grade of animals fed milo (in Texas) was slightly but not significantly better than from any other feeding.

Returns were calculated from cost, performance and sale data. A summary of performance, sale prices and carcass values is presented in Table 4. Feed costs per pound of gain ranged from $.388 for steers fed corn silage in South Mississippi to $.621 for steers fed corn there (Table 5). Costs of gain were almost identical for steers fed corn at the Brown Loam Branch and those fed milo in Texas. Steers fed corn in Texas had feed costs per pound of gain that were slightly less than those for steers fed corn at the South Mississippi Branch.

Total cost per pound of gain (Table 5) includes all costs (i.e., interest, transportation, facility charges, etc.). The corn-silage diet at the South Mississippi Branch afforded the lowest overall cost per pound of gain ($.697), and the corn diet at that station was the highest ($.871).

A summary of income and expenses (Table 6) compiled from three-year average budgets (Appendix B) reveals not only that all trials were not profitable but also that none even recovered direct (operating) expenses. If only direct costs are considered, per head losses were least ($17.79) in the corn silage feeding trial at the South Mississippi Branch and largest ($84.43) in the corn-feeding option at that station. When all costs are considered, the two programs at the South Mississippi Branch maintain their

Table 2. Performance data, by diet, for steers finished in Mississippi and Texas, three-year averages, 1980-1982

Item	Unit	Diet and Location: Corn, Brown Loam	Corn, South MS	Corn, Texas	Milo, Texas	Corn Silage, South MS
Initial full wt.	Lb	767.8[a/]	753.0[b/]	762.6[a/]	767.5[a/]	749.7[b/]
Initial shrink	Lb	40.5	37.6	73.4	76.0	35.7
Final shrunk wt.	Lb	1081.7[a/]	1055.1[b/]	1084.6[a/]	1089.4[a/]	1062.0[b/]
Final shrink	Lb	44.5	30.5	41.9	36.1	32.1
Gain	Lb	313.9	302.1	322.0	323.9	312.3
Feeding period	Days	123	132	116	116	139
Feed consumption per head	Lb	2906.2	3034.8	2895.9	2944.3	6845.6
Average daily gain (Initial full wt. to final shrunk wt.)	Lb	2.55[b/]	2.31[c/]	2.78[a/]	2.78[a/]	2.25[c/]
Feed conversion (lb. feed/Lb gain)	Ratio	9.26	10.04	8.99	9.09	21.92

[abc/] Any two means on same line which do not share a letter in common differ significantly at the 5% level of probability as judged by Fisher's protected LSD.

Table 3. Carcass data, by diet, for steers finished in Mississippi and Texas, three-year averages, 1980-1982

Item	Unit	Diet and Location: Corn Brown Loam	Corn South MS	Corn Texas	Milo Texas	Corn Silage South M
Carcass wt.	Lb.	656.5[e]	644.8[f]	674.3[d]	669.0[d]	638.1[1]
Dressing	%	61.2[dg]	60.3[e]	62.0[df]	61.4[d]	60.1[e]
Fat thickness	In.[1/]	.56[d]	.51[ef]	.47[f]	.41[g]	.55
KHP Fat	%	2.5[d]	2.2[e]	2.0[f]	1.8[f]	2.4[d]
Loin eye area	Sq. In.	11.76[eg]	11.39[fg]	11.79[e]	12.24[d]	11.37
Yield grade	--	3.1[d]	3.0[d]	3.0[d]	2.7[e]	3.1[d]
Marble score	[2/]	6.7[d]	6.6[d]	6.3[d]	6.4[d]	6.7[d]
USDA quality grade	[3/]	11.2[d]	11.0[d]	11.0[d]	11.1[d]	11.2[d]

[1/] Measured at 12th rib.

[2/] 6 = slight; 7 = small; etc.

[3/] 11 = high good; 12 = low choice, etc.

[defg] Any two means on the same line which do not share a letter in common differ significantly at the 5% level of probability as judged by Fisher's protected LSD.

Table 4. Performance, sale prices and carcass values for steers finished in Mississippi and Texas, three-year averages, 1980-1982

Item	Unit	Diet and Location: Corn Brown Loam	Corn South MS	Corn Texas	Milo Texas	Corn Silage South M
Initial full wt.	Lb	767.8	753.0	762.6	767.5	749.7
Final shrunk wt.	Lb	1081.7	1055.1	1084.6	1089.6	1060.0
Gain	Lb	313.9	302.1	322.0	322.1	310.3
Live wt. sale Price (calculated)	Dol/Cwt	62.00	60.60	62.00	61.40	59.70
Carcass sale price (actual)	Dol/Cwt	98.42	99.22	99.77	100.06	99.78
Carcass value	Dol	670.65	639.39	672.45	669.01	633.82

Table 5. Summary costs/lb of gain from initial full weight to final shrunk weight for steers finished in Mississippi and Texas, three-year averages, 1980-1982

Item	Unit	Diet and Location: Corn Brown Loam	Corn South MS	Corn Texas	Milo Texas	Corn Silage South MS
Feed cost/head	Dol	174.82	187.64	191.88 [1/]	177.72 [1/]	120.42
Feed cost/lb gain	Dol	.557	.621	.596	.552	.388
Other direct cost/lb Gain	Dol	.198	.205	.235	.234	.189
Facility cost/lb gain	Dol	.075	.109	0	0	.120
Total cost/lb gain	Dol	.830	.871	.856	.830	.697

[1/] Includes a $15/ton management charge.

Table 6. Summary of income and expenses per head, by diet and location, for steers finished Mississippi and Texas, three-year averages, 1980-1982

	Diet and Location: Corn Brown Loam	Corn South MS	Corn Texas	Milo Texas	Corn Silage South MS
Income	670.65	639.39	672.45	669.01	633.82
Direct expenses	720.67	723.82	744.57	736.33	651.61
Net returns over direct expenses	-50.02	-84.43	-72.12	-67.32	-17.79
Facility	23.51	32.80	[1/]	[1/]	37.31
Net returns over all expenses	-73.53	-117.23	-72.12	-67.32	-55.10

[1/] Includes in a $15 per ton of feed charge for "service and facility costs" and listed among other direct expenses.

relative loss positions among all trials---least ($55.10) in the silage-feeding trial and largest ($117.23) in the corn-feeding program.

Breakeven prices; i.e., prices at which steers finished at specified costs must sell if finishers are to recover all costs, were lowest ($64.99/cwt) for steers fed corn silage at the South Mississippi Branch, highest ($71.71/cwt) for those fed corn at that station (Table 7). These breakeven prices are based on the established purchase prices and other costs as listed in the budget tables (Appendix B).

Appendix C contains an estimate of the construction and ownership costs of a dirt feedlot similar to the Brown Loam Branch facility and a slatted floor facility that should produce results similar to those at the South Mississippi Branch facility. These tables are included to indicate the general complexity of the feedlot equipment involved and the likely magnitude of investment should commercial feeding be under-taken in Mississippi.

Table 7. Breakeven sale prices per hundredweight for steers finished in Mississippi and Texas, by diet and location, three-year averages, 1980-1982

Item	Diet and Location				
	Corn			Milo	Corn Silage
	Brown Loam	South MS	Texas	Texas	South MS
	dol/cwt				
Calculated live weight sale price	62.00	60.60	62.00	61.40	59.70
Breakeven sale price [a] above direct expenses	66.62	68.60	68.64	67.58	61.47
Breakeven sale price [a] above all expenses	68.79	71.71	68.64	67.58	64.99

[a] Purchase price of feeder steers averaged $63/cwt. Sensitivity analysis indicates that each $1/cwt increase (decrease) in feeder purchase price adds (subtracts) $.75/cwt in breakeven sale price.

Summary

The objective of this study was to investigate differences between finishing wintergrazed steers in Mississippi and the High Plains of Texas. Three locations were involved in the study, two in Mississippi and one in Texas. The three diets fed were a corn-based diet at each location, a milo-based diet in Texas and a corn silage diet at one Mississippi location. Three feeding trials were conducted at each location in 1980, 1981, and 1982.

Steers fed in Texas gained slightly faster than those fed in Mississippi, as evidenced by average daily gain. Characteristics that determine USDA quality grades and yield grades showed little or no difference among carcasses of steers fed in Texas or Mississippi.

Economic comparison of the five groups indicated substantially lower costs per pound of gain for the cattle fed corn silage in Mississippi than for those in the other trials. Substantial negative net returns above all costs for the three-year period were shown for all five groups. Steers fed corn silage in South Mississippi had the lowest negative net return above all costs with $-55.10. The two groups of steers fed in Texas followed with net returns of $-67.32 and $-72.12. Steers fed corn at the Brown Loam Branch showed net returns of $73.53 and those fed corn at the South Mississippi Branch had a net return of $-117.23.

None of the net returns appear appealing to potential cattle feeders. Of course, these returns are based on a particular set of steer prices, feed costs and prices of other inputs. As these prices and costs change, the net returns necessarily will change. Hence, new estimates of net returns must be made in every situation, and the information herein should provide a general guide to the elements that must be considered in making those estimates. Price levels of finished steers were not sufficiently high to offset the costs encountered during the three-month feeding periods in each of the three years of this study.

Reference

Tyner, Fred H. and Thomas D. Scroggins, "Investment, Operating Costs and Estimated Returns for 500 and 1000 Head Beef Cattle Feedlots, Mississippi, 1979." Mississippi Agricultural and Forestry Experiment Station Bulletin 888, February 1981.

Appendix A:

Feed and Feeding Information

Appendix A, Table 1. Prices for feed ingredients, composition of finishing diets and cost per ton for finishing diets for five feeding periods, 1980

Ingredients	May 28			July 1			July 30			August 27			October 1		
	S. M.[a] Exp. Sta.	B. L.[b] Exp. Sta.	TX	S. M. Exp. Sta.	B. L. Exp. Sta.	TX	S. M. Exp. Sta.	B. L. Exp. Sta.	TX	S. M. Exp. Sta.	B. L. Exp. Sta.	TX	S. M. Exp. Sta.	B. L. Exp. Sta.	TX
	Ingredient Prices														
	dol/ton														
Corn	106.07	106.07	104.00	111.61	111.61	113.28	125.71	125.71	123.28	131.78	131.78	126.14	126.16	126.16	127.93
Cottonseed Hulls	40	40	40.40	40	40	41.00	40	40	47	40	40	51	40	40	51
Cottonseed Meal	121.25	125	145	142.50	150.00	147	169.25	180.00	177	205.00	205.00	195	202.50	205.00	195
Supplement	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Milo			95.80			102.61			113.80			116.20			120.80
Molasses			115			115			115			115			115
Corn Silage	18			18			18			18			18		

CORN FINISHING DIRT	Percent of Ration	Cost of Diet													
		dol/ton													
Corn	73	77.43	77.43	75.92	81.48	81.48	82.69	91.77	91.77	89.99	96.20	96.20	92.08	92.10	92.10	93.39
Cottonseed Hulls	15	6.00	6.00	6.06	6.00	6.00	6.15	6.00	6.00	7.05	6.00	6.00	7.65	6.00	6.00	7.65
Cottonseed Meal	6	7.28	7.50	8.70	8.55	9.00	8.82	10.16	10.80	10.62	12.30	12.30	11.70	12.15	12.30	11.70
Supplement	6	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64
Total		99.35	99.57	99.32	104.67	105.12	106.30	116.57	117.21	116.30	123.14	123.14	120.07	118.89	118.74	121.38
+ $15 yardage feed				15			15			15			15			15
Total for Texas				114.31			121.30			131.30			135.07			136.38

(continued)

Appendix A, Table 1. (Continued)

Ingredients		May 28			July 1			July 30			August 27			October 1		
		S. M. Exp. Sta.	B. L. Exp. Sta.	TX	S. M. Exp. Sta.	B. L. Exp. Sta.	TX	S. M. Exp. Sta.	B. L. Exp. Sta.	TX	S. M. Exp. Sta.	B. L. Exp. Sta.	TX	S. M. Exp. Sta.	B. L. Exp. Sta.	TX
		Cost of Diet														
		(dol/ton)														
CORN SILAGE FINISHING DIET	Percent of Ration															
Corn	7.1	7.53			7.92			8.93			9.36			8.96		
Cottonseed Meal	4.6	5.58			6.56			7.78			9.43			9.32		
Corn Silage	87.7	15.79			15.79			15.79			15.79			15.79		
TM Salt ($20/ton)	.2	.24			.24			.24			.24			.24		
Dicalcium Phosphate ($340/ton)	.1	.34			.34			.34			.34			.34		
Ground Limestone ($60/ton)	.3	.18			.18			.18			.18			.18		
Total		29.66			31.03			33.26			35.34			34.83		
MILO FINISHING DIET	Percent of Ration															
Milo	71.4		68.40			73.26			81.25			82.97			86.25	
Cottonseed Hulls	15		6.06			6.15			7.05			7.65			7.65	
Cottonseed Meal	6		8.70			8.82			10.62			11.70			11.70	
Molasses	1.6		1.84			1.84			1.84			1.84			1.84	
Supplement	6		8.64			8.64			8.64			8.64			8.64	
Total			93.64			98.71			109.40			112.80			116.08	
+ $15 yardage fee			15			15			15			15			15	
Total for Texas			108.64			113.71			124.40			127.80			131.08	

a/ MAFES South Mississippi Branch

b/ MAFES Brown Loam Branch

Appendix A. Table 2. Number of days in feeding period, average daily feed consumption, pounds of feed fed and feed cost, by diet and location, 1980

Diet	Location	Number of Days in Feeding Period	Average Daily Feed Consumption	Pounds of Feed Fed	Feed Cost	Total Cost
		days	pounds/head/day	pounds	dol/ton	dol/head
Corn Diet	MAFES South Mississippi Branch	28	21.37	598.36	99.35	29.72
		28	22.66	634.48	104.67	33.21
		28	25.11	703.08	116.57	40.98
		28	27.38	766.64	123.14	47.20
		12	25.00	300.00	118.89	17.83
						168.94
Corn Diet	MAFES Brown Loam Branch	29	25.60	742.40	99.57	36.96
		34	24.74	841.16	105.12	44.21
		23	25.10	577.30	117.21	33.83
		28	25.44	712.32	123.14	43.86
		11	25.96	285.56	118.74	16.95
						175.81
Corn Diet	Amarillo, Texas	28	21.95	614.6	114.32	35.13
		28	21.42	599.76	121.30	36.38
		36	26.62	958.32	131.30	62.92
		20	22.92	445.8	135.07	30.11
		13	18.57	241.41	136.38	16.46
						181.00
Corn Silage Diet	MAFES South Mississippi Branch	28	44.94	1255.52	29.66	18.62
		28	53.44	1496.32	31.03	23.22
		28	53.86	1508.08	33.26	25.08
		28	56.37	1578.36	35.34	27.89
		33	52.90	1745.70	34.83	30.40
						125.21
					Rumensin Vitamin ADE	+ 7.43
						134.18
Milo Diet	Amarillo, Texas	28	25.85	723.80	108.64	39.32
		28	27.39	766.92	113.71	43.60
		36	26.46	952.56	124.40	59.25
		20	23.07	461.40	127.80	29.48
		13	19.89	258.57	131.08	16.95
						188.60

Appendix A, Table 3. Prices for feed ingredients, composition of finishing diets and cost per ton for finishing diets for five feeding periods, 1981

Ingredients	May 29 S. M. Exp. Sta. [a]	May 29 B. L. Exp. Sta. [b]	May 29 TX	July 2 S. M. Exp. Sta.	July 2 B. L. Exp. Sta.	July 2 TX	July 31 S. M. Exp. Sta.	July 31 B. L. Exp. Sta.	July 31 TX	August 28 S. M. Exp. Sta.	August 28 B. L. Exp. Sta.	August 28 TX	September 25 S. M. Exp. Sta.	September 25 B. L. Exp. Sta.	September 25 TX
	dol/ton														
Corn	140.07	140.07	130.07	129.71	129.71	128.28	135.45	135.45	129.54	119.36	119.36	112.04	114.00	114.00	--
Cottonseed Hulls	151.00	151.00	113.50	102.00	102.00	108.50	118.00	118.00	103.50	121.00	121.00	98.50	113.00	113.00	--
Cottonseed Meal	200.75	209.75	196.00	201.00	201.00	186.00	202.00	202.00	183.50	196.00	196.00	166.00	181.00	181.00	--
Supplement	197.58	197.58	189.80	197.58	197.58	189.80	197.58	197.58	189.80	197.58	197.58	189.80	197.58	197.58	--
Milo			110.00			115.70			114.80			97.30			--
Molasses			112.18			112.18			96.13			96.13			--
Corn Silage	18.00			18.00			18.00			18.00			18.00		
CORN FINISHING DIET — Percent of Ration	cost (dol)														
Corn 73	102.25	102.25	94.95	94.68	94.68	93.64	98.88	98.88	94.55	87.13	87.13	81.79	83.22	83.22	--
Cottonseed Hulls 15	22.65	22.65	17.02	15.30	15.30	16.27	17.70	17.70	15.52	18.15	18.15	14.78	16.95	16.95	--
Cottonseed Meal 6	12.04	12.04	11.76	12.06	12.06	11.16	12.12	12.12	11.81	11.76	11.76	9.96	10.86	10.86	--
Supplement 6	11.85	11.85	11.39	11.85	11.85	11.39	11.85	11.85	11.39	11.85	11.85	11.39	11.85	11.85	--
Total	148.79	148.79	135.12	137.89	137.89	132.46	140.55	140.55	132.48	128.89	128.89	117.92	122.88	122.88	--
+ $15 yardage feed			15.00			15.00			15.00			15.00			--
Total for Texas			150.12			147.46			147.48			132.92			--

(continued)

Appendix A, Table 3. (Continued)

Ingredients		May 29			July 2			July 31			August 28			September 25		
		S. M. Exp. Sta.	B. L. Exp. Sta.	TX	S. M. Exp. Sta.	B. L. Exp. Sta.	TX	S. M. Exp. Sta.	B. L. Exp. Sta.	TX	S. M. Exp. Sta.	B. L. Exp. Sta.	TX	S. M. Exp. Sta.	B. L. Exp. Sta.	TX
CORN SILAGE FINISHING DIET	Percent of Ration	cost (dol)														
Corn	7.1	9.94			9.21			9.62			8.47			8.09		
Cottonseed Meal	4.6	9.23			9.25			9.29			9.02			8.32		
Corn Silage	87.7	15.78			15.78			15.78			15.78			15.78		
TM Salt ($31/ton)	.2	.06			.06			.06			.06			.06		
Dicalcium Phosphate ($305/ton)	.1	.30			.30			.30			.30			.30		
Ground Limestone ($47/ton)	.3	.14			.14			.14			.14			.14		
Total		35.45			34.74			35.19			33.77			32.69		
MILO FINISHING DIET	Percent of Ration															
Milo	77.3		85.03			89.43			88.74			75.21			--	
Cottonseed Hulls	10		11.35			10.85			10.35			9.85			--	
Cottonseed Meal	.7		1.37			1.30			1.28			1.16			--	
Molasses	6.0		6.73			6.73			5.77			5.77			--	
Supplement	6.0		11.34			11.38			11.38			11.38			--	
Total			115.86			119.69			117.52			103.37			--	
+ $15 yardage feed			15.00			15.00			15.00			15.00			--	
Total for Texas			130.86			134.69			132.52			118.37			--	

a/ MAFES South Mississippi Branch

b/ MAFES Brown Loam Branch

Appendix A, Table 4. Number of days in feeding period, average daily feed consumption, pounds of feed fed and feed cost, by diet and location, 1981

Diet	Location	Number of Days in Feeding Period	Average Daily Feed Consumption	Pounds of Feed Fed	Feed Cost	Total Cost
		days	pounds/head/day	pounds	dol/ton	dol/head
Corn	MAFES South Mississippi Branch	28	24.15	676.25	148.79	50.31
		28	21.55	603.38	137.89	46.60
		28	23.44	656.25	140.55	46.11
		28	21.95	614.63	128.89	39.61
		13	19.23	250.00	122.88	15.36
						197.99
Corn	MAFES Brown Loam Branch	31	21.27	659.37	148.79	47.56
		28	22.58	632.2	137.89	43.58
		30	23.18	695.4	140.55	48.87
		3	26.25	78.75	128.89	5.07
						145.08
Corn	Amarillo, Texas	33	21.33	704.17	150.12	52.85
		26	25.96	675.00	147.46	49.77
		28	25.35	709.67	147.48	52.33
		14	25.31	354.35	132.92	23.55
						178.45
Corn	MAFES South Mississippi Branch	28	42.27	1183.38	35.45	20.97
		28	46.19	1293.38	34.74	22.46
		28	48.51	1358.13	35.19	23.89
		28	50.85	1423.75	33.77	24.04
		13	52.33	680.38	32.69	11.12
						102.48
					Rumensin Vitamin ADE	+ 7.43
						109.91
Milo	Amarillo, Texas	33	21.33	704.17	130.86	46.07
		26	23.37	607.92	134.69	40.94
		28	25.95	726.62	132.52	48.14
		14	23.64	331.00	118.37	19.59
						154.74

Appendix A, Table 5. Prices for feed ingredients, composition of finishing diets and cost per ton for finishing diets for five feeding periods, 1982

Ingredients	June 2 S. M.[a] Exp. Sta.	June 2 B. L.[b] Exp. Sta.	June 2 TX	June 30 S. M. Exp. Sta.	June 30 B. L. Exp. Sta.	June 30 TX	July 28 S. M. Exp. Sta.	July 28 B. L. Exp. Sta.	July 28 TX	August 25 S. M. Exp. Sta.	August 25 B. L. Exp. Sta.	August 25 TX	September 22 S. M. Exp. Sta.	September 22 B. L. Exp. Sta.	September 22 TX
	dol/ton														
Corn	125.35	140.07	119.64	119.64	119.64	120.35	115.00	115.00	117.67	111.43	111.43	106.42	104.29	104.29	100.18
Cottonseed Hulls	70.00	70.00	19.00	70.00	70.00	31.00	70.00	70.00	33.60	70.00	20.00	31.40	70.00	70.00	33.60
Cottonseed Meal	157.50	157.50	133.40	175.00	175.00	146.00	182.50	182.50	157.00	180.00	180.00	146.00	175.00	175.00	158.60
Supplement	181.20	181.20	158.20	181.20	181.20	158.20	181.20	181.20	158.20	181.20	181.20	158.20	181.20	181.20	158.20
Milo			106.20			105.50			103.90			94.20			91.00
Molasses			78.20			78.20			76.20			76.20			76.20
Corn Silage	18.00			18.00			18.00			18.00			18.00		
CORN FINISHING DIET — Percent of Ration	cost (dol)														
Corn — 73	91.62	91.62	87.34	87.34	87.34	87.88	83.95	83.95	85.90	81.34	81.34	77.69	76.13	74.67	73.58
Cottonseed Hulls — 15	10.50	10.50	2.85	10.50	10.50	4.65	10.50	10.50	5.04	10.50	10.50	4.71	10.50	10.50	5.04
Cottonseed Meal — 6	9.45	9.45	8.02	10.50	10.50	8.76	10.95	10.95	9.42	10.80	10.80	8.76	10.50	10.50	9.52
Supplement — 6	10.87		9.49	10.87		9.49	10.89		9.49	10.87		9.49	10.87	10.98	9.49
Total	122.44	122.44	107.70	119.21	119.21	110.78	116.27	116.27	109.85	112.71	112.71	100.65	108.00	108.00	97.63
+ $15 yardage feed			15.00			15.00			15.00			15.00			15.00
Total for Texas			122.70			125.78			124.85			115.65			112.63

(ontinued)

Appendix A, Table 5. (Continued)

Ingredients		May 29			July 2			July 31			August 28			September 25		
		S. M. Exp. Sta.	B. L. Exp. Sta.	TX	S. M. Exp. Sta.	B. L. Exp. Sta.	TX	S. M. Exp. Sta.	B. L. Exp. Sta.	TX	S. M. Exp. Sta.	B. L. Exp. Sta.	TX	S. M. Exp. Sta.	B. L. Exp. Sta.	TX
CORN SILAGE FINISHING DIET	Percent of Ration	cost (dol)														
Corn	7.1	8.90			8.49			8.17			7.91			7.40		
Cottonseed Meal	4.6	7.25			8.05			8.39			8.28			8.05		
Corn Silage	87.7	15.78			15.78			15.78			15.78			15.78		
TM Salt ($40/ton)	.2	.08			.08			.08			.08			.08		
Dicalcium Phosphate ($418/ton)	.1	.42			.42			.42			.42			.42		
Ground Limestone ($89.60/ton)	.3	.27			.27			.27			.27			.21		
Rumensin + Vitade		.07			.07			.07			.07			.07		
Total		32.77			33.16			33.18			32.81			32.01		
MILO FINISHING DIET	Percent of Ration															
Milo	77.3		82.09			81.55			80.31			72.82			70.34	
Cottonseed Hulls	10		1.90			3.1			3.36			3.14			3.36	
Cottonseed Meal	.7		.94			1.02			1.10			1.02			1.11	
Molasses	6.0		4.96			4.96			4.96			4.96			4.96	
Supplement	6.0		9.49			9.49			9.49			9.49			9.49	
Total			99.38			100.12			99.22			91.43			89.26	
+ $15 yardage feed			15.00			15.00			15.00			15.00			15.00	
Total for Texas			114.38			115.12			114.22			106.43			104.26	

a/ MAFES South Mississippi Branch

b/ MAFES Brown Loam Branch

Appendix A, Table 6. Number of days in feeding period, average daily feed consumption, pounds of feed fed and feed cost, by diet and location, 1982

Diet	Location	Number of Days in Feeding Period	Average Daily Feed Consumption	Pounds of Feed Fed	Feed Cost	Total Cost
		days	pounds/head/day	pounds	dol/ton	dol/head
Corn	MAFES South Mississippi Branch	28	18.22	510.1	122.44	31.23
		29	22.51	652.8	119.21	38.91
		27	25.63	692.0	116.27	40.23
		28	25.15	704.2	112.71	39.69
		34	24.48	832.3	108.00	44.93
						195.99
Corn	MAFES Brown Loam Branch	28	26.65	746.2	122.44	45.68
		28	27.86	780.1	119.21	46.50
		28	28.17	788.8	116.27	45.86
		28	28.18	789.0	112.71	44.40
		14	27.85	390.0	108.00	21.06
						203.56
Corn	Amarillo, Texas	28	23.42	655.8	122.70 [1/]	40.23
		28	29.17	816.7	125.78	51.36
		28	27.39	767.1	124.85	47.89
		28	29.10	814.9	115.65	47.12
		12	27.50	330.0	112.63	18.58
						205.18
Corn	MAFES South Mississippi Branch	28	42.06	1177.7	35.77	19.89
		29	52.36	1518.4	33.16	25.18
		27	53.17	1435.6	33.18	23.82
		28	49.43	1384.0	32.81	22.70
		34	47.00	1598.0	32.01	25.58
						117.17
Milo	Amarillo, Texas	28	24.34	681.7	114.38 [1/]	38.99
		28	29.12	815.4	115.12	46.93
		28	27.51	776.4	114.22	43.99
		28	29.34	821.6	106.43	43.72
		12	25.9	310.8	104.26	16.20
						189.83

[1/] Includes $15/ton for management services.

Appendix A, Table 7. Summary of feed consumption by years, by diet and location, for steers finished in Mississippi and Texas, 1980-1982

Year	Diet and Location				
	Corn			Milo	Silage
	Brown Loam	South MS	Texas	Texas	South MS
	lbs.				
1980	3158.7	3002.6	2859.9	30633	7584.0
1981	2065.7	2800.5	2443.2	2369.7	5839.0
1982	3494.1	3301.4	3384.5	3399.9	7113.7
Total	8718.5	9104.5	8687.6	8832.9	20536.7
Average	2906.2	3034.8	2895.9	2944.3	6845.6

Appendix B:
Summary Feeding Budgets

Appendix B, Table 1. Summary budget (per head) for steers fed a corn finishing diet at the MAFES Brown Loam Branch, three-year averages, 1980-1982

Item	Unit	No.	Price	Total
Income:				
Steer Sale	lb	1,081.7	.62 a/	670.65
Direct Expenses:				
Feeder Purchase	lb	768	.63	483.84
Interest on Feeder	dol	482.76	.05 b/	24.14
Feed	ton	1.45	122.63	174.82
Interest on Feed	dol	174.82	.0125 c/	7.00
Utilities & Fuel	head	1	2.31 d/	2.31
Labor	hour	4.2	3.45 d/	14.49
Vet and Medicine	head	1	1.75 e/	1.75
Transportation and Marketing	head	1	7.50	7.50
Death Loss (1% of purchase)	dol	482.76	.01	4.82
Total Direct Expenses				720.67
Net Returns Over Direct Expenses				-50.02
Facility and Equipment	head	1	23.51 f/	23.51
Net Returns Over All Expenses				-73.53

a/Steers were actually sold on a yield and grade basis.

b/Reflects a 15% interest rate for 4 months of use.

c/Reflects a 15% interest rate on the feed cost. The interest was charged at the end of each feeding period for the accumulated feed and interest charges.

d/Reflects data from [1]. The $3.35 includes minimum wage, social security, etc.

e/Assumes worming ($1.00) and implant ($.75) at time steers are placed in the feedlot.

f/Approximated from an unpublished report by Laughlin, Ag. Economics Dept., MSU, 1981. Assuming 2 turns/yr (1000 head). See Appendix B, Table 1.

Appendix B, Table 2. Summary budget (per head) for steers fed a corn diet at the MAFES South Mississippi Branch, three-year averages, 1980-1982

Item	Unit	No.	Price	Total
Income:				
Steer Sale	lb	1,055.1	.606 [c]	639.39
Direct Expenses:				
Feeder Purchase	lb	753	.63	474.39
Interest on Feeder	dol	472.50	.05 [b]	23.62
Feed	ton	1.52	124.24	187.64
Interest on Feed	dol	187.64	.0125 [c]	7.39
Utilities & Fuel	head	1	2.31 [d]	2.31
Labor	hour	4.2	3.45 [d]	14.49
Vet and Medicine	head	1	1.75 [e]	1.75
Transportation and Marketing	head	1	7.50	7.50
Death Loss (1% of purchase)	head	472.50	.01	4.73
Total Expenses				723.82
Net Returns Over Direct Expenses				-84.43
Facility and Equipment	head	1	32.80 [f]	32.80
Net Returns Over All Expenses				-117.23

[a] Steers were actually sold on a yield and grade basis, with price converted to liveweight basis.

[b] Reflects 15% interest charged for 4 months of use.

[c] Reflects 15% interest charged on feed cost. Interest was charged at the beginning of each feeding period on accumulated feed and interest charges.

[d] Reflects data from [1]. The $3.35 includes minimum wage, social security, etc.

[e] Assumes worming ($1.00) and implant ($.75) at time steers are placed in the feedlot.

[f] Approximated from an unpublished report by Laughlin, Ag. Economics Dept., MSU, 1981. Assuming two turns/yr (1000 head). See Appendix B, Table 2.

Appendix B, Table 3. Summary budget (per head) for steers fed a corn diet at Amarillo, Texas, three-year averages, 1980-1982

Item	Unit	No.	Price	Total
Income:				
Steer Sale	lb	1,084.6	.62 [a/]	672.45
Direct Expenses:				
Feeder Purchase	lb	763	.63	480.69
Interest on Feeder	dol	480.00	.05 [b/]	24.00
Feed & Management	ton	1.43	131.41 [c/]	188.21
Interest on Feed	dol	188.21	.0125 [d/]	7.46
Vet and Medicine	head	1	3.00	3.00
Transportation	head	1	31.61	31.61
Death Loss (2% of feeder purchase)	dol	780.06	.02	9.60
Total Expenses				744.57
Net Returns Over All Expenses				-72.12

[a/] Steers were actually sold on a yield and grade basis, with price converted to liveweight basis.

[b/] Reflects 15% interest charged for 4 months of use.

[c/] Reflects $15 ton for feeding services.

[d/] Reflects a 15% interest rate on the feed cost. The interest was charged at the end of each feeding period for the accumulated feed and interest charges.

Appendix B, Table 4. Summary budget (per head) for steers fed a milo diet at Amarillo, Texas, three-year averages, 1980-1982

Item	Unit	No.	Price	Total
Income:				
Steer Sale	lb	1,089.5	.614 [a/]	669.01
Direct Expenses:				
Feeder Purchase	lb	767	.63	483.21
Interest on Feeder	dol	482.14	.05 [b/]	24.10
Feed & Management	ton	1.49	120.68 [c/]	177.72
Interest on Feed	dol	177.72	.0125 [d/]	7.05
Vet and Medicine	head	1	3.00	3.00
Transportation	head	1	31.61	31.61
Death Loss (2% of feeder purchase)	dol.	482.14	.02	9.64
Total Expenses				736.33
Net Returns Over All Expenses				-67.32

[a/] Steers were actually sold on a yield and grade basis, with price converted to liveweight basis.

[b/] Reflects 15% interest charged for 4 months of use.

[c/] Includes $15/ton for feeding services.

[d/] Reflects 15% interest on the feed cost. The interest was charged at the end of each feeding period for the accumulated feed and interest charges.

Appendix B, Table 5. Summary budget (per head) for steers fed a silage diet at the MAFES South Mississippi Branch, three-year averages, 1980-1982

Item	Unit	No.	Price	Total
Income:				
Steer Sale	lb	1,060.0	.597 a/	633.82
Direct Expenses:				
Feeder Purchase	lb	750	.63	472.50
Interest on Feeder	dol	472.50	.05 b/	23.62
Feed	ton	3.44	35.15	120.42
Interest on feed	dol	120.42	.0125 b/	4.30
Utilities & Fuel	head	1	2.31 c/	2.31
Labor	hour	4.2	3.45 d/	14.49
Vet and Medicine	head	1	1.75 e/	1.75
Transportation and Marketing	head	1	7.50	7.50
Death Loss (1% of purchase)	dol.	472.50	.01	4.72
Total Expenses				651.61
Net Returns Over Direct Expenses				-17.79
Facility and Equipment	head	1	37.31 f/	37.31
Net Returns Over All Expenses				-55.10

a/Steers were actually sold on a yield and grade basis, with price converted to liveweight basis.

b/Reflects 15% interest charged for 4 months of use.

c/Reflects a 15% interest rate on the feed cost. The interest was charged at the beginning of each feeding period on accumulated feed and interest charges.

d/Reflects data from [1]. The $3.35 includes minimum wage, social security, etc.

e/Assumes worming ($1.00) and implant ($.75) at time steers are placed in the feedlot.

f/Approximated from an unpublished report by Laughlin, Ag. Economics Dept., MSU, 1981. Assuming two turns/yr (1000 head). See Appendix B, Table 3.

Appendix C:
Cost of Feedlots

Appendix C, Table 1. Construction and ownership costs of a dirt feedlot with concrete slab feeding area, 500 head capacity, 1980

Item	Amount	Expected life	Repair cost	Avg. an. repair cost	11% amortized fixed cost
	$	years	% new cost	$	%
Facility:					
(1) Lot fencing (1376/in. ft. @ $1.85)	2,551.00	20	50	63.78	320.34
(2) Concrete slab feeding apron (206' x 20' x two @ $1.64/sq. ft.)	13,536.00	20	--	--	1,699.79
(3) Pole-type shed w/metal roof (206' x 34' @ $1.45/sq. ft.)	10,191.00	20	25	127.38	1,279.72
Cleaning Equipment:					
(1) Tractor	9,974.00	10	75	748.05	1,693.60
(2) Scraper blade	792.00	10	40	31.68	134.48
(3) Frontend loader	2,347.00	10	40	93.88	398.52
(4) Manure spreader	4,928.00	10	40	197.12	836.78
Feeding Equipment:					
(1) Fenceline feed bunks 384 linear ft. @ 18.81/l. ft. 2/post & cable-installed	7,223.00	20	50	180.58	907.03
(2) Mixer truck--BJM 900 mixer (320 cu. ft.) with load cells, mounted on 1980 Ford F700 truck with heavy duty equip.	24,641.00	10	50	1,232.05	4,184.08
(3) Storage * feed mix building (25 x 50 metal)	14,081.00	20	25	1,760.01	1,768.23
(4) 18" hammer mill-5h.p. motor (100 ft. augers)	4,342.00	10	50	217.10	737.28
(5) 2 holding bins w/auger loaders, fan & heater--300 bu. capacity each	10,744.00	10	25	268.60	1,824.35
(6) Working, bins (2 bins-4 ton capacity-installed)	2,004.00	10	25	50.10	340.28
Working Barn:					
(1) Metal roof structure (38' x 38') @ 4.08 sq. ft.	5,896.00	20	25	73.70	740.39
(2) Pen fencing (210 linear ft.) @ 7.04/l. ft.	1,478.00	20	25	18.48	185.60
(3) Working chute (manual)	1,056.00	10	25	26.40	179.31
(4) Storage	1,173.00	20	25	14.66	147.30
Water:					
(1) Water well (4" well, 500 ft. deep)	4,694.00	10	50	234.70	797.05
Total	97,924.00	--	--	5,338.27	18,174.13
Amount/head[a/]					23.51

[a/] Assumes two turns/year (1,000 head).

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Postemergence Herbicides and Trifluralin for Control of Rhizome Johnsongrass in COTTON

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USDA-ARS
in cooperation with

MAFES MISSISSIPPI AGRICULTURAL & FORESTRY EXPERIMENT STATION
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Postemergence Herbicides and Trifluralin for Control of Rhizome Johnsongrass in

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Postemergence Herbicides and Trifluralin for Control of Rhizome Johnsongrass in Cotton

Johnsongrass has remained a problem for cotton producers in the southern United States despite technological advances in herbicide application (4, 12). This perennial grass can reduce cotton yield (7, 8, 9) and make harvesting difficult where infestations are heavy.

Most articles about johnsongrass control in cotton pertain to control with the dinitroaniline herbicides (5, 7, 8, 16). However, numerous reports describing several methods for johnsongrass control in soybeans have been published (1, 2, 13, 14).

The dinitroaniline herbicides at high application rates have been reported to inhibit lateral root production by cotton plants. Seedling johnsongrass can be controlled on a sandy soil with 0.75 lb/acre, which is twice the normal rate of trifluralin (Treflan®); however, greenhouse studies indicated that tap-root length and lateral root production by cotton plants were reduced (8).

Until recently, the methanearsonates (MSMA and DSMA) were the only available selective herbicides that could be used postemergence (POE) to control johnsongrass in cotton. Keeley and Thullen (9) reported a 20% increase in cotton yield and a 64% reduction in johnsongrass density following application of disodium methanearsonate (DSMA); however, the yield obtained with this treatment was 40% less than the yield of the hand-weeded plot. Herbicides to which cotton is tolerant and johnsongrass is susceptible have been developed recently (3, 6, 10, 15, 18) Because of the growth habit of this rhizomatous weed (11), POE herbicides must be translocated basipetally to the rhizomes to result in plant death (19).

Johnsongrass that is allowed to grow to maturity in cotton fields is harvested along with the cotton and results in grade and price reduction of lint due to grass content and color.

This research was conducted to determine (a) the phytotoxicity of several POE herbicides applied to cotton for rhizome johnsongrass control, (b) whether one or two applications are necessary for control and (c) if the normal use rate (1X) of Treflan applied as a preplant incorporated (PPI) treatment will enhance johnsongrass control with the POE grass herbicides. The use rate of Treflan by itself in this study was not selected to control rhizome johnsongrass but was included to see if this herbicide in sequential combination with the POE treatments would increase johnsongrass control.

MATERIALS AND METHODS

The field experiment was initiated in 1981 at the MAFES Delta Branch on a Bosket silt loam soil with a natural infestation of rhizome johnsongrass. Initial herbicide treatments were arranged in a randomized complete block design with three replications. Each plot was four 40-inch wide and 40-ft long rows. The field was bedded with a four-row hipper in March and was rebedded in April. Nitrogen was applied at 90 lb/acre as a broadcast treatment before the initial bedding operation. Application and weather data are presented in Table 1.

A bed conitioner was used to level all rows, and Treflan was applied at 0.75 lb/acre to one-half of the plots. The bed conditioner was used again on April 27 to prepare the final seedbed by incorporating the Treflan to a depth of about 2 inches. Cotton was planted at the rate of 15 lb/acre on April 27.

CGA-82725, 0.5 lb/acre; fluazifop (Fusilade®), 0.5 lb/acre; DPX-Y6202 (Assure®), 0.5 lb/acre; sethoxydim (Poast®), 0.5 lb/acre and haloxyfop (Verdict®), 0.25 lb/acre were applied POE 27 days after planting to plots that had received Treflan treatment and to plots with no prior herbicide treatment. The POE treatments were applied to the foliage of 2- to 5-inch seedling and 12-inch rhizome johnsongrass. An example of the johnsongrass infestation level following cultivation is shown in Figure 1.

About one month later, one half of each plot was treated POE again at one-half the rate used earlier, except for the full rate of Assure applied after Treflan. The second POE treatment was applied to 5-to 24-inch johnsongrass on two rows of the four-row plot so that one and two treatments could be compared. The number of applications would, therefore, be considered a subunit treatment in a split-plot design.

All herbicides were applied with a tractor-mounted spray boom calibrated to deliver 20 gallons of spray solution per acre. A nonionic surfactant (Sterox NJ®) was added to each POE treatment at 0.25% (v/v).

The experiment was repeated in 1982 with the addition of Fusilade at 0.25 lb/acre followed by 0.125 lb/acre applied POE to a plot that had been treated with Treflan. The experimental design, number of replications and johnsongrass size

Table 1. Treatment and weather information for a johnsongrass control experiment at the MAFES Delta Branch, 1981.

Treatment		Application[a]		Weather data				
Herbicide(s)	Rate lb/acre	Date	Method	Days between last rainfall and treatment	Rainfall inches	Days between treatment and first rain	Rainfall inches	Temperature at treatmen (°F)
CGA-82725 + CGA-82725	0.5 + 0.25	5/21;7/3	POE	5;2	1;1	4;2	.75;1	73;81
Fusilade® + Fusilade	0.5 + 0.25	5/21;7/3	POE	5;2	1;1	4;2	.75;1	73;81
Assure® + Assure	0.5 + 0.25	5/21;7/3	POE	5;2	1;1	4;2	.75;1	73;81
Poast® + Poast	0.5 + 0.25	5/21;7/3	POE	5;2	1;1	4;2	.75;1	73.81
Verdict® + Verdict	0.25 + 0.125	5/21;7/3	POE	5;2	1;1	4;2	.75;1	73;81
Treflan® + CGA-82725 + CGA-82725	0.75 + 0.25 + 0.25	4/27;5/21; 7/3	PPI + POE	4;5;2	.5;1;1	13;4;2	.5;.75;1	86;73;81
Treflan + Assure + Assure	0.75 + 0.25 + 0.25	4/27;5/31; 7/3	PPI + POE	4;5;2	.5;1;1	13;4;2	.5;.75;1	86;73;81
Treflan + Poast + Poast	0.75 + 0.5 + 0.25	4/27;5/21; 7/3	PPI + POE	4;5;2	.5;1;1	13;4;2	.5;.75;1	86;73;81
Treflan + Verdict + Verdict	0.75 + 0.25 + 0.125	4/27;5/21; 7/3	PPI + POE	4;5;2	.5;1;1	13;4;2	.5;.75;1	86;73;81
Treflan	0.75	4/27	PPI	4	.5	12	.5	86
None	---	---	---	---	---	---	---	---

[a]Planting date was April 27.

were as described previously. The PPI (April 28) and first POE treatments (May 26) were applied with a tractor-mounted spray boom, and the second POE treatments (June 30) were applied with a CO^2-pressurized backpack sprayer calibrated to deliver the same carrier rate as did the tractor-mounted sprayer. Atplus 411 F®, a crop oil-surfactant blend[1], was used as an adjuvant at 0.5% (v/v). Application and weather data are listed in Table 2.

Johnsongrass control on a scale of 0 to 100% (0 = no effect and 100 = death of all plants) was rated visually each year. Initial johnsongrass control ratings were made 44 and 37 days after treatment (DAT) in 1981 and 1982, respectively, and preharvest control ratings were made each year. The cotton was machine harvested each year.

All data each year were subjected to analysis of variance. Means of initial ratings of single herbicide applications were separated by Waller-Duncan's Bayesian *k*-ratio (k = 100) *t*-test (<0.05) (17). LSD (<0.05) values for pre-harvest

Figure 1. Example of initial johnsongrass infestation levels before POE treatment.

[1]83% mineral oil/17% surfactant (oxysorbic polyoxyethylene sorbiton fatty acid ester

Table 2. Treatment and weather information for a johnsongrass control experiment at the MAFES Delta Branch, 1982.

Treatment		Application[a]		Weather data				
Herbicide(s)	Rate lb/acre	Date	Method	Days between last rainfall and treatment	Rainfall inches	Days between treatment and first rain	Rainfall inches	Temperature at treatment (°F)
CGA-82725 + CGA-82725	0.5 + 0.25	5/26;6/30	POE	1;3	.5;1.5	8;1	.5;.5	83;84
Fusilade® + Fusilade	0.5 + 0.25	5/26;6/30	POE	1;3	.5;1.5	8;1	.5;.5	83;84
Assure® + Assure	0.5 + 0.25	5/26;6/30	POE	1;3	.5;1.5	8;1	.5;.5	83;84
Poast® + Poast	0.5 + 0.25	5/26;6/30	POE	1;3	.5;1.5	8;1	.5;.5	83;84
Verdict®	0.25 + 0.125	5/26;6/30	POE	1;3	.5;1.5	8;1	.5;.5	83;84
Treflan® + CGA-82725 + CGA-82725	0.75 + 0.5 + 0.25	4/28;5/26; 6/30	PPI, POE	9;1;3	1.5;.5;1.5	1;8;1	.75;.5;.5	73;83;84
Treflan + Fusilade + Fusilade	0.75 + 0.25 + 0.125	4/28;5/26; 6/30	PPI, POE	9;1;3	1.5;.5;1.5	1;8;1	.75;.5;.5	73;83;84
Treflan + Assure + Assure	0.75 + 0.25 + 0.25	4/28;5/26; 6/30	PPI, POE	9;1;3	1.5;.5;1.5	1;8;1	.75;.5;.5	73;83;84
Treflan + Poast + Poast	0.75 + 0.5 + 0.25	4/28;5/26; 6/30	PPI, POE	9;1;3	1.5;.5;1.5	1;8;1	.75;.5;.5	73;83;84
Treflan + Verdict + Verdict	0.75 + 0.25 + 0.125	4/28;5/26; 6/30	PPI, POE	9;1;3	1.5;.5;1.5	1;8;1	.75;.5;.5	73;83;84
Treflan	0.75	4/28	PPI	9	1.5	1	.75	73
None	---	---	---	---	---	---	---	---

[a]Planting date was April 28.

johnsongrass control ratings and yield determinations were calculated. The LSD tests were used to test rate-by-compound subclass means. The intended use of the LSD values was for comparisons of one and two applications within a compound or comparison of all herbicides with one or two applications and was not intended for use as a multiple range test.

Results and Discussion

One application of each POE herbicide in 1981 gave > 90% control of johnsongrass at 44 DAT (Table 3), and differences among treatments were not significant ($P < .05$). A single application of POE herbicides in 1982 also gave > 90% control at 37 DAT except for CGA-82725 alone, Poast alone and Poast applied after Treflan. Degrees of initial burndown are shown in Figure 2.

Banks and Tripp (3) reported better johnsongrass control with two applications of Poast than with one, and our data imply the same for Poast. Two applications of the POE herbicides tested in this study gave > 90% control of johnsongrass at harvest except for CGA-82725 alone and Treflan + Poast in 1982 (Table 4).

Table 3. Johnsongrass control in cotton following one postemergence application of five postemergence herbicides alone and in sequence with trifluralin, by treatment, MAFES Delta Branch, 1981 and 1982.

Treatment		Johnsongrass control	
		1981	1982
Herbicide(s)[a]	Rate (lb/a)	OAT[b] 44	OAT[b] 37
		---------(%)---------	
CGA-82725	0.5	96 a	88 cd
Fusilade®	0.5	99 a	98 ab
Assure®	0.5	97 a	100 a
Poast®	0.5	97 a	83 d
Verdict®	0.25	100 a	98 ab
Treflan® + CGA-82725	0.75 + 0.5	96 a	95 abc
Treflan + Fusilade[c]	0.75 + 0.25	--	92 bc
Treflan + Assure	0.75 + 0.25	99 a	99 ab
Treflan + Poast	0.75 + 0.5	98 a	82 d
Treflan + Verdict	0.75 + 0.25	100 a	99 ab
Treflan	0.75	0 b	0 e
Control	--	0 b	0 e

[a]Means within a column followed by the same letter are not significantly different at the 5% level using Waller-Duncan's Bayesian K-ratio (K=100) t-test.
[b]Days after foliar treatment.
[c]Not applied in 1981.

Pre-harvest control of johnsongrass with two applications of the POE herbicides tested in this study was equal to or better than control with one application (Table 4), and only two treatments (CGA-82725 and Poast following Treflan) failed to give > 90% control when applied twice. However, one application of Fusilade alone, Verdict alone and Assure or Verdict following Treflan gave > 90% control each year, and an example of the control attained with one application of these herbicides is shown in Figure 3.

Control of johnsongrass with one application was significantly lower ($P < .05$) than with two applications of CGA-82725 alone, Poast alone and Treflan + CGA-82725 each year and Treflan + Poast in 1982 (Table 4). This suggests that two applications of CGA-82725 and Poast at the rates evaluated, with or without Treflan, are needed to increase johnsongrass control in cotton significantly.

Treflan has been used extensively in the Delta of Mississippi for control of johnsongrass in cotton for many years but has not eradicated it. Use of Treflan at twice the recommended rate has reduced johnsongrass populations and increased cotton yields significantly (8). However, pre-harvest johnsongrass control ratings in our study revealed that the addition of Treflan at 0.75 lb/acre did not increase johnsongrass control.

Two applications of POE herbicides in 1981 resulted in consistently higher yields (but not significant at the 5% level) across herbicides except for Fusilade without Treflan and Treflan + Verdict. This was not evident in 1982.

All treatments resulted in significantly higher yields than from the untreated control and the Treflan standard, which will not control rhizome johnsongrass in cotton effectively. Consequently, johnsongrass populations in the Treflan plot (Figure 4) were so dense that lint yield was very low in 1981, and mechanical harvesting was not possible in 1982.

Figure 2. Degrees of initial burndown with the POE herbicides.

Table 4. Pre-harvest control of johnsongrass and seed cotton yield as affected by one or two applications of five postemergence herbicides alone and in sequence with trifluralin, by treatment, MAFES Delta Branch, 1981 and 1982.

Treatment		Johnsongrass control		Yield seed cotton	
Herbicide(s)	Rate (lb/Acre)	1981	1982	1981	1982
		----(%)-----		--(lb/A)----	
CGA-82725	0.5	78	63	1510	2420
CGA-82725 + CGA-82725	0.5 + 0.25	90	87	2420	2490
Fusilade®	0.5	95	99	2370	2760
Fusilade + Fusilade	0.5 + 0.25	98	100	1610	2900
Assure®	0.5	89	100	1580	2400
Assure + Assure	0.5 + 0.25	99	100	1650	2740
Poast®	0.5	85	55	1650	2130
Poast + Poast	0.5 + 0.25	98	92	1760	2120
Verdict®	0.25	98	100	1450	2780
Verdict + Verdict	0.25 + 0.125	99	100	1520	2600
Treflan® + CGA-82725	0.75 + 0.5	70	78	1540	2840
Treflan + CGA-82725 + CGA-82725	0.75 + 0.5 + 0.25	99	99	1810	2960
Treflan + Fusilade	0.75 + 0.25	--[a]	86		3130
Treflan + Fusilade + Fusilade	0.75 + 0.25 + 0.126	--	100	--	2750
Treflan + Assure	0.75 + 0.25	94	99	1830	2840
Treflan + Assure + Assure	0.75 + 0.25 + 0.25	99	100	1920	2790
Treflan + Poast	0.75 + 0.5	92	53	1590	2190
Treflan + Poast + Poast	0.75 + 0.5 + 0.25	98	86	1930	2030
Treflan + Verdict	0.75 + 0.25	98	99	1770	2840
Treflan + Verdict + Verdict	0.75 + 0.25 + 0.125	98	100	1680	2970
Treflan	0.75	0	0	470	0
None	--	0	0	110	0
LSD ($P < .05$) One versus two applications within herbicide		11	15	500	600
		14	19	550	780
LSD ($P < .05$) Between herbicides with one or two applications					

[a]Not applied in 1981

Figure 3. Example of johnsongrass control attained with one application of Fusilade, Verdict or Assure.

Figure 4. Johnsongrass populations in a plot treated with the Treflan standard.

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